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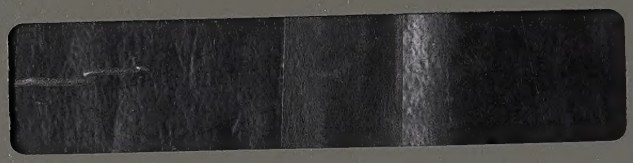

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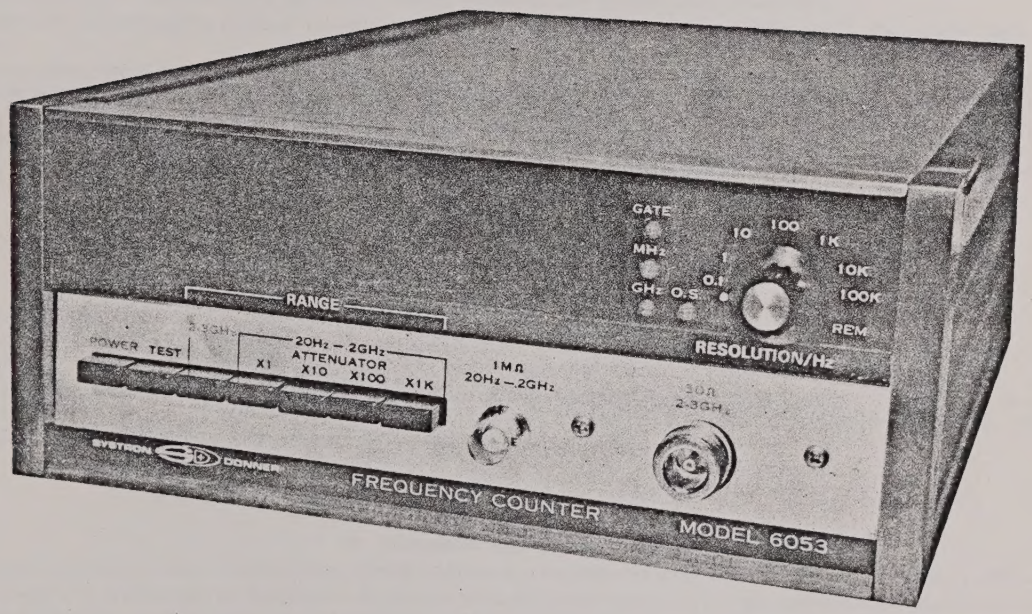
INSTRUCTION MANUAL



*MODEL 6053 FREQUENCY COUNTER
FORMERLY DESIGNATED MODEL 6053/3

CONCORD INSTRUMENT
DIVISION

MODEL 6053
FREQUENCY COUNTER

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SYSTRON DONNER

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SYSTRON DONNER
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The Test & Measurement Group of Systron Donner warrants that at the time of shipment the products manufactured by Systron Donner's T & M Group and sold hereunder will be free from defects in material and workmanship and will conform to the specifications furnished by or approved in writing by Systron Donner's T & M Group.

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C The warranty period for modified standard products, custom products, or new spare part assemblies will be 90 days from the date of shipment.

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Divisions in the Test & Measurement Group include:
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January 1982

SYSTRON DONNER
Member THORN EMI Group

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CAUTION

IMPORTANT OPERATING INSTRUCTIONS
(200 MHz to 3 GHz)

Signals to the "D" Input (50 Ω) connector *MUST NOT EXCEED* +20 dBm (2.2 V rms) at any time or serious (expensive) damage to the input circuit will result. Always monitor unknown signal levels first (terminated in 50 Ω), before connecting into the "D" Input of the instrument. When input levels exceed +20 dBm, insert a variable, calibrated attenuator between the signal source and the Model 6053.

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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

The SD Model 6053/3 is a portable, half-rack, microwave counter capable of automatically measuring signal frequencies ranging from 20Hz to 3GHz. Extensive use of integrated circuits and other solid-state components ensures excellent reliability and trouble-free maintenance.

The Model 6053/3 microwave counter provides the following operating features:

1. An easily read storage-type display which permits the initial reading to be observed while another is being made.
2. Direct reading of frequency with no front panel adjustment necessary.
3. Automatic units of measure and decimal point location.
4. Completely remote programmable: programming inputs for all front panel controls and attenuator switch (optional).
5. BCD recorder output (optional).
6. Unit can be operated on either 115V or 230V ac line.

1.2 FUNCTIONAL DESCRIPTION

The Model 6053/3 features the Automatic Computing Transfer Oscillator (ACTO®) technique in conjunction with a new high-sensitivity, high input impedance .2GHz amplifier to offer unparalleled performance. The basic seven-digit instrument receives its input on one of two input connectors.

1. BNC - This 20Hz to .2GHz input channel features 10mV rms sensitivity and one megohm impedance. Input signals may be attenuated by factors from 1 to 1000, in decade steps.
2. "N" type connector - Frequencies from .2GHz to 3GHz can be measured with sensitivities of 50mV rms into 50 ohms.

1.3 SPECIFICATIONS

Table 1.1 lists the specifications applicable to the Model 6053/3:

TABLE 1.1 SPECIFICATIONS

Low-Frequency Range Input	Frequency Range:	20Hz to .2GHz.
	Type of Signal:	CW.
	Sensitivity:	10mV rms.

TABLE 1.1 SPECIFICATIONS (Cont'd)

	Maximum Input Without Damage:	600V dc, 200V rms.
	Input Impedance:	1MΩ.
	Input Connector:	Type BNC.
	Accuracy:	±1 count ±time base accuracy.
	Resolution:	100kHz to 0.1Hz in decade steps.
	Reads In:	MHz or GHz.
High-Frequency Range Input	Frequency Range:	.2GHz to 3GHz.
	Type of Signal:	CW.
	Sensitivity:	50mV rms (-7 dBm).
	Maximum Input Without Damage:	2.33V rms (+20 dBm).
	Maximum Usable Input:	500mV rms (+7 dBm).
	Input Impedance:	50Ω nominal.
	Input Connector:	Type N.
	Accuracy:	±1 count ±time base accuracy.
	Resolution:	100kHz to 0.1Hz in decade steps.
	Reads In:	MHz or GHz.
	Acquisition Time:	200ms typical.
	FM Tolerance:	Maximum of 0.1% deviation at modulation frequency of 60Hz. Permissible deviation is reduced 50% for each increasing octave of modulation frequency.

TABLE 1.1 SPECIFICATIONS (Cont'd)

	Lock-On Range:	Approximately 5% of input frequency.
Time Base	Crystal Frequency:	1MHz.
	Stability:	±2 parts in 10^6/month.
	Temperature:	Less than ±1 part in 10^6 from +15°C to +35°C; less than ±3 parts in 10^6 from 0°C to +50°C.
	Line Voltage:	Less than ±1 part in 10^6 for 10% change in line voltage specified.
	Output Frequency:	1MHz, 3V p-p minimum open circuit; source impedance 2000Ω maximum.
	External Input:	1MHz sinewave, 1V rms into 1000Ω, 10V rms maximum.
	Higher Stability Available:	See options listed.
General	Registration:	7 digits, expandable to 9.
	Reads In:	MHz or GHz with positioned decimal point.
	Display Storage:	Provides a continuous display of most recent measurement.
	Rear Panel:	1MHz internal/external switch, BNC connector for 1MHz input or output, line cord, oscillator adjustment, fuse.
	Operating Temperature:	0°C to +50°C.
	Dimensions:	3-1/2" high x 8-3/8" wide x 13" deep.
	Weight:	10 lbs. net (15 lbs. shipping.
	Power:	115V/230Vac, 50 to 60Hz.

TABLE 1.1 SPECIFICATIONS (Cont'd)

Options	B3	Aging Rate: <±3 parts in 10^8/24 hours. Long-Term Aging Rate: ±3 parts in 10^8/30 days. Short-Term Aging Rate: ±1 part in 10^{10} rms/1s average.
	B	Aging Rate: <±1 part in 10^9/24 hours. Long-Term Aging Rate: ±3 parts in 10^8/30 days. Short-Term Aging Rate: ±1 part in 10^{10} rms/1s average.
	B4	Aging Rate: <±5 parts in 10^{10}/24 hours. Long-Term Aging Rate: ±1.5 parts in 10^8/30 days. Short-Term Aging Rate: ±5 parts in 10^{11}/1s average.
	E & EE	Additional decade indicator to increase count capacity to 8 (E) or 9 (EE) digits.
	D3	1-2-4-8 BCD Output: Coded output information of front panel reading appears at rear panel connector. Positive logic "1" state level at +5V nominal, "0" state level at 0V ±0.5V; a +5V print command at the end of each conversion, positive reference level is +4V, negative reference level is +1V with a column capacity equal to the number of digits.
	P	Remote programming of range, resolution and attenuators. T^2L, DTL compatible.

CHAPTER 2
INSTALLATION

2.1 INTRODUCTION

Procedures for inspection and initial installation of SD Model 6053/3 are outlined below. Reshipment instructions have been included should the instrument require return to Systron-Donner Corporation.

2.2 RECEIVING INSPECTION

Before accepting the instrument from the shipper, inspect the shipping container for signs of external damage. Any sign of such damage must be noted by both the shipper and customer; then, should be reported to the insurance investigator.

As soon as the instrument is unpacked, inspect it for shipping damage. Check for scratches or dents, broken or cracked knobs, and damaged connectors. Should any damage be found, notify your nearest Systron-Donner representative -- do not use the instrument until instructed to do so by the representative.

2.3 INSTALLATION

Initial installation of the Model 6053/3 includes power connection and verification of internal cooling.

2.3.1 Power

The Model 6053/3 may be operated from a 115 or 230-volt ac (±10%) power source. Conversion from one source to another is performed by changing jumpers on the power transformer (See Figure 2.1).

The instrument is factory-supplied with a 1A, 3AG fuse for 115V operation. Be sure to replace this fuse with a .5A, 3AG fuse when operating with 230V.

CAUTION

Before connecting instrument into ac power line, be certain that transformer is wired for proper power.

The Model 6053/3 is equipped with a standard three-conductor power cord that automatically grounds the unit when a matching power outlet is available. An adapter which provides the instrument ground should be used whenever the power cord is connected to a two-conductor outlet.

2.3.2 Cooling

The Model 6053/3 Counter uses forced air cooling. The air intake is located on the rear panel of the instrument. Make sure the air intake filter is clean and in place before applying power to the instrument. Under no circumstances should the air intake be obstructed while the instrument is operating.

2.4 RESHIPMENT

Should it become necessary to reship the instrument, contact the nearest Systron-Donner field office for shipping instructions. If possible, use the original packaging materials, or replace the packing in accordance with MIL-P-116 and MIL-E-17555E. The field office can provide materials similar to those used for original factory packaging. All correspondence should refer to the full nomenclature and serial number of the instrument.

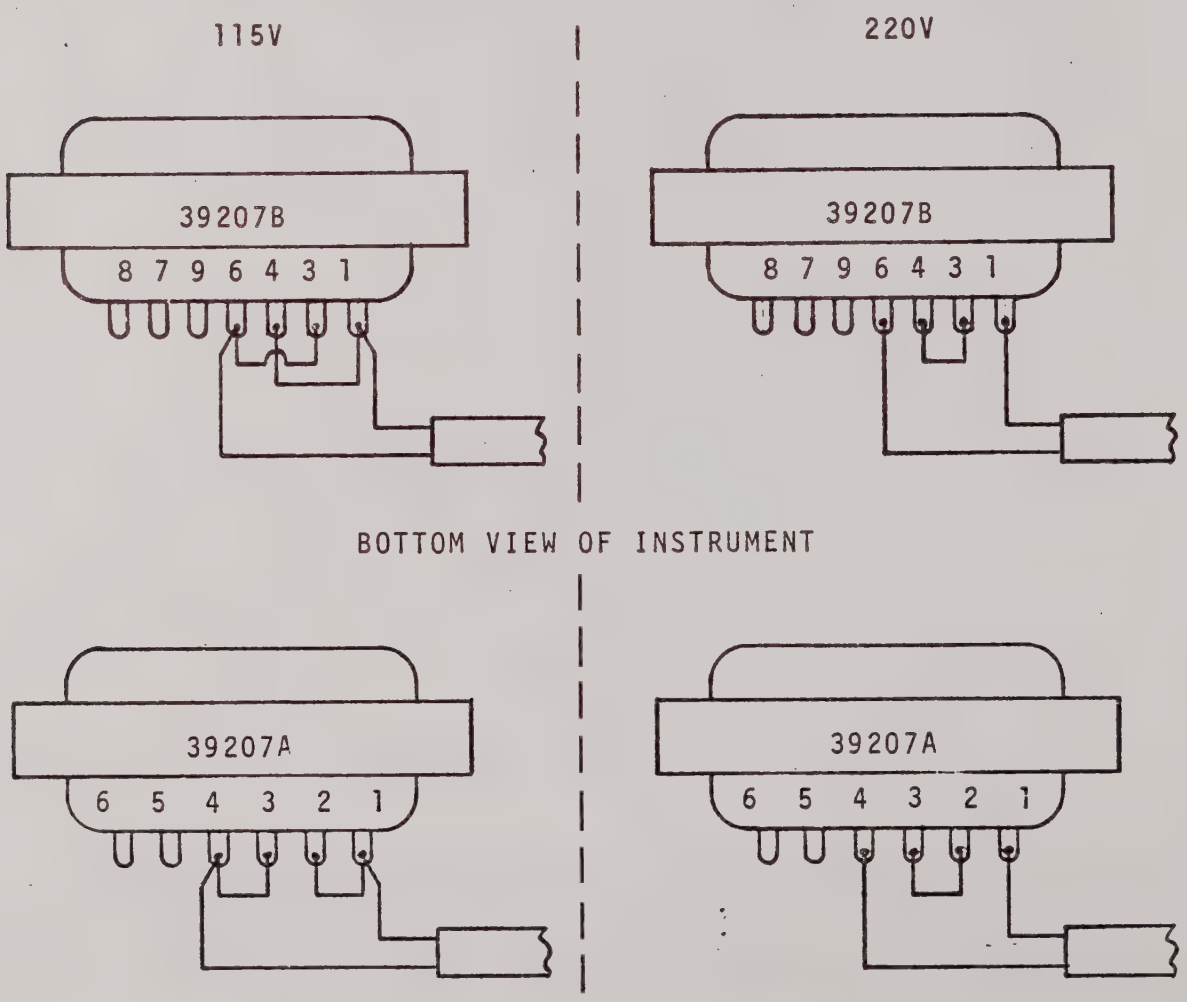


FIGURE 2.1 TRANSFORMER JUMPER POSITION FOR POWER CHANGE

CHAPTER 3
OPERATION

3.1 INTRODUCTION

This section describes the SD Model 6053/3 controls, connectors, and indicators. Initial turn-on and operational checks are included, along with step-by-step operating procedures listing each basic function of the counter.

3.2 CONTROLS, CONNECTORS, AND INDICATORS

Figures 3.1 and 3.2 illustrate the Model 6053/3 front and rear panel controls, connectors, and indicators. Table 3.1 and 3.2 provide a description of these functions.

TABLE 3.1 FRONT PANEL

FIGURE	INDEX	NAME		FUNCTIONS
3.1	1	POWER (pushbutton)		Applies power to the instrument.
3.1	2	TEST (pushbutton)		Applies the 1MHz internal oscillator frequency to the internal circuits for test.
3.1	3	RANGE .2 - 3GHz (pushbutton)		Activates "N" connector (see Index 11) for input of .2-3GHz.
3.1	4	RANGE 20Hz - .2GHz ATTENUATOR (pushbuttons)	X1 X10 X100 X1k	Attenuates the input applied to the 1MΩ, 20Hz - .2GHz BNC connector by a factor of 1 (X1), 10 (X10), 100 (X100), and 1000 (X1k).
3.1	5	DISPLAY (indicator)		Digital indicators and polarized window provide glare-free viewing of measurement.
3.1	6	20Hz - .2GHz 1MΩ (connector)		Type BNC provides signal input connection for the 20Hz - .2GHz range of measurement.

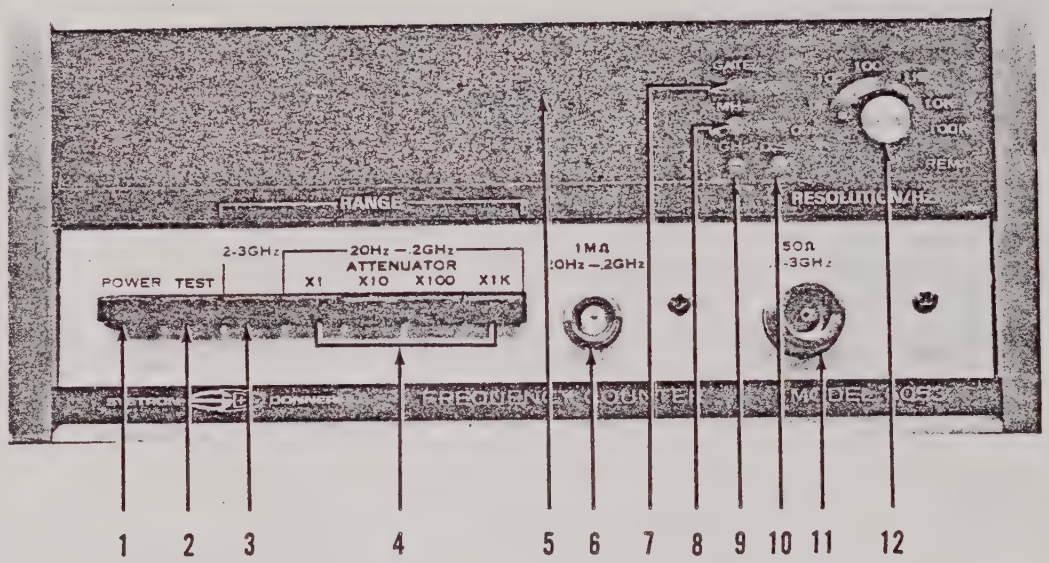


FIGURE 3.1 FRONT PANEL, MODEL 6053/3

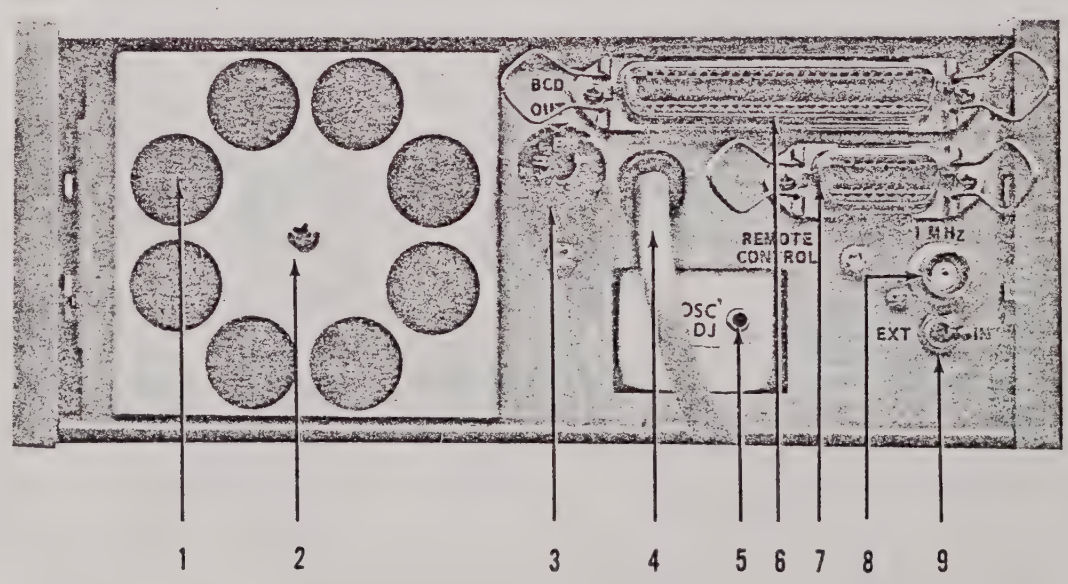


FIGURE 3.2 REAR PANEL, MODEL 6053/3

TABLE 3.1 FRONT PANEL (Cont'd)

FIGURE	INDEX	NAME		FUNCTIONS
3.1	7	GATE (indicator)		Light-emitting diode (LED) indicates when the count gate is open or closed.
3.1	8	MHz (indicator)		Light-emitting diode (LED) when energized, indicates that readout units are in MHz.
3.1	9	GHz (indicator)		Light-emitting diode (LED) when energized, indicates that readout units are in GHz.
3.1	10	O.S. (indicator)		Light-emitting diode (LED) when energized, indicates that a reading is off-scale.
3.1	11	.2 - 3GHz 50Ω (connector)		Type N connector provides signal input connection for .2 - 3GHz.
3.1	12	RESOLUTION/Hz (switch)	10^{-1}, 1, 10, 10^{2}, 10^{3}, 10^{4}, 10^{5}, REM.	Switch provides 7 ranges of resolution and a remote position for programmable operation.

TABLE 3.2 REAR PANEL

FIGURE	INDEX	NAME	FUNCTION
3.2	1	FAN INTAKE	Air intake for cooling.
3.2	2	FAN SCREEN	Screens dust and particulate matter from cooling air (should be cleaned weekly).
3.2	3	FUSE HOLDER	Retains power fuse.
3.2	4	POWER CORD	3-conductor grounded power cord.

TABLE 3.2 REAR PANEL (Cont'd)

FIGURE	INDEX	NAME		FUNCTION
3.2	5	1MHz OSCILLATOR (controls)	Coarse Fine	Adjusts the internal 1MHz oscillator frequency.
3.2	6	BCD OUT (optional connector)		Provides BCD information compatible with IC logic.
3.2	7	REMOTE CONTROL (optional connector)		Permits remote operation of attenuator and all front panel controls.
3.2	8	1MHz (connector)		Provides 1MHz out when INT/EXT switch is in INT position. Provides input for external 1MHz signal when INT/EXT switch is in EXT position.
3.2	9	INT/EXT (switch)		Provides selection of internal or external time base.

3.3 INITIAL TURN-ON AND OPERATIONAL CHECK

The following procedures verify operation of the Model 6053/3 prior to on-line usage. Successful completion of these checks should precede any performance tests.

1. Connect power cord to 115V ac source.

CAUTION

Be sure transformer is wired for 115V operation (see Section 2.3.1).

2. Position INT/EXT switch (Index 9, Figure 3.2) to INT.
3. Press POWER pushbutton to ON (Index 1, Figure 3.1).
4. Press TEST pushbutton to ON (Index 2, Figure 3.1).
5. Check instrument readout (Table 3.3) while turning RESOLUTION/Hz switch through the (7) selectable ranges.

TABLE 3.3 CHECK, IN TEST

RESOLUTION/Hz SWITCH POSITION	READOUT INDICATION
10^{-1}	XX.0000000 MHz (O.S.)
1	XX1.000000 MHz
10	XX01.00000 MHz
10^2	XX001.0000 MHz
10^3	XX0.001000 GHz
10^4	XX00.00100 GHz
10^5	XX000.0010 GHz
REMOTE	Same as above

XX - Additional digits available, E and EE Options

3.4 OPERATING PROCEDURES

The following procedures outline the general method for operating the Model 6053/3 in the two measurement ranges.

3.4.1 General

Operation is fully automatic and requires no special adjustments.

3.4.2 20Hz - .2GHz RANGE

1) Press POWER pushbutton to ON.
2) Press proper attenuator pushbutton in accordance with input level. If input level is unknown, select highest attenuation level (X1k) first; then, proceed to select lower attenuation levels (X100, X10, or X1) to obtain consistent count readings.
3) Apply 20Hz - .2GHz signal to 1MΩ Type BNC connector.
4) Select desired readout resolution.
5) Measurement is automatic.

3.4.3 .2 - 3GHz RANGE

1) Press POWER pushbutton to ON.
2) Press .2 - 3GHz pushbutton

3) Apply .2 - 3 GHz signal to 50 Ω Type N connector.

4) Select desired readout resolution.

5) Measurement is automatic.

3.4.4 Turn-off Procedures

1) Press POWER pushbutton to OFF.

2) Disconnect power cord from ac source.

NOTE

Do not disconnect power cord from ac source if B, B3, or B4 Oscillator Option is installed. (Crystal oven must remain energized at all times to ensure high-accuracy readout operation.)

CHAPTER 4

THEORY OF OPERATION

4.1 INTRODUCTION

Included in this chapter are the general theory and circuit descriptions of the Model 6053 Counter. A general block diagram, along with a timing diagram, are included for reference. Schematics will be found in Chapter 6.

4.2 GENERAL THEORY

The Automatic Computing Transfer Oscillator (ACTO) operates by phase-locking a low frequency oscillator to the applied RF input frequency and computing the harmonic multiple "N". The counter time base is then expanded such that the counter will count the low frequency oscillator for a period equal to "N" times the selected time base. The result is a direct indication of the RF input frequency. Figure 4.1 depicts the basic block diagram for the ACTO. As illustrated, the phase-lock loop, incorporates a harmonic phase detector, amplifier search oscillator, and a voltage-controlled oscillator. The free-running search oscillator sweeps the voltage-controlled oscillator over a narrow band of frequencies, producing an output varying in frequency between 17.5 and 19.5 MHz. This signal is applied to the harmonic phase detector and is phase-compared to the RF input. When an exact oscillator harmonic is encountered, a dc voltage is generated which disables the sweep oscillator and locks the the voltage controlled oscillator to a sub-multiple of the input frequency.

Since the harmonic number (N) is unknown, it is not possible to measure the exact input frequency. Therefore, a second output from the voltage controlled oscillator is extracted and applied to a single-sideband generator. The generator is modulated at a 1 kHz rate resulting in an output equal to the oscillator's frequency shifted by 1 kHz. This signal is now applied to a harmonic phase detector, the output of which is equal to 1 kHz x N.

Since the original 1 kHz modulation frequency and the 1 kHz x N are present, it is possible to compare the two frequencies digitally and extract the corresponding harmonic number (N). This is the function of the N compute and control circuit. Having extracted N, the N compute and control circuit expands the time base period by the appropriate factor of N to provide a direct readout of the input frequency.

4.3 CIRCUIT DESCRIPTIONS

4.3.1 POWER SUPPLY (Schematic D05362301)

The Model 6053 power supply provides both regulated and unregulated voltages from either a 115 V or 230 V, 50 to 60 Hz source.

Primary power arrives at the primary windings of power transformer T1 from the ac line cord, through a line filter, fuse F1, and a POWER/ON switch S1. The power transformer provides three separate secondary windings from which the following voltages are obtained: +225 V dc (display indicators), +5 V dc (logic) and ±15V dc (bias). A special ACTO +5V dc and -5.2V dc are provided with additional circuitry.

+225 Supply (unregulated)

The +225 V supply voltage is produced in the following manner: approximately 175 V rms from the T1 secondary winding, 7-8 is half-wave rectified by CR9. The resultant voltage is distributed to the Display indicator circuits on the Readout Board via pin E30.

+15V Supply (regulated)

The regulated +15V supply is based on 35V rms from the center- tapped secondary winding, 12-13-14. A full-wave bridge rectifier CR1-CR4, and filter capacitors C3 and C4 produce the raw dc potential which is applied to the integrated circuit regulator, U1. The regulated +15 V output is then controlled by the series pass transistor Q1, permitting about 300 mA maximum current at pins E19-E21.

-15V Supply (regulated)

The regulated -15V supply is based on 35V rms from the center-tapped secondary winding, 12-13-14. A full-wave bridge rectifier, CR1-CR4. and filter capacitors C3 and C4 produce the raw dc potential which is applied to the integrated circuit regulator, U1. The regulated -15 V output is then controlled by the series pass transistor Q2, permitting about 300 mA maximum current at pins E26-E28.

+5V Supply (regulated)

From secondary winding 9-10-11 of T1 and the full-wave rectifier CR5-CR6, a raw +9 V potential is fed to IC regulator U2. The resulting regulated +5 V is then passed by Q3, providing about 1.35 A of current at E24-E25.

-5.2V Supply (regulated)

From secondary winding 9-10-11 of T1 and the full-wave rectifier CR7-CR8 a raw -9 V potential is filtered by C6, C8 and fed to IC regulator U4, providing the resulting regulated -5.2 V output at E31-E32.

ACTO +5V (regulated)

This supply consists of IC regulator U3, pass switch Q4 and the ACTO ENABLE transistors Q5/Q6. The pass transistor Q4 allows 2.0 A maximum at E22-E23. E29 is the ACTO enable line which enables Q6 when the ACTO line is grounded, turning on U3.

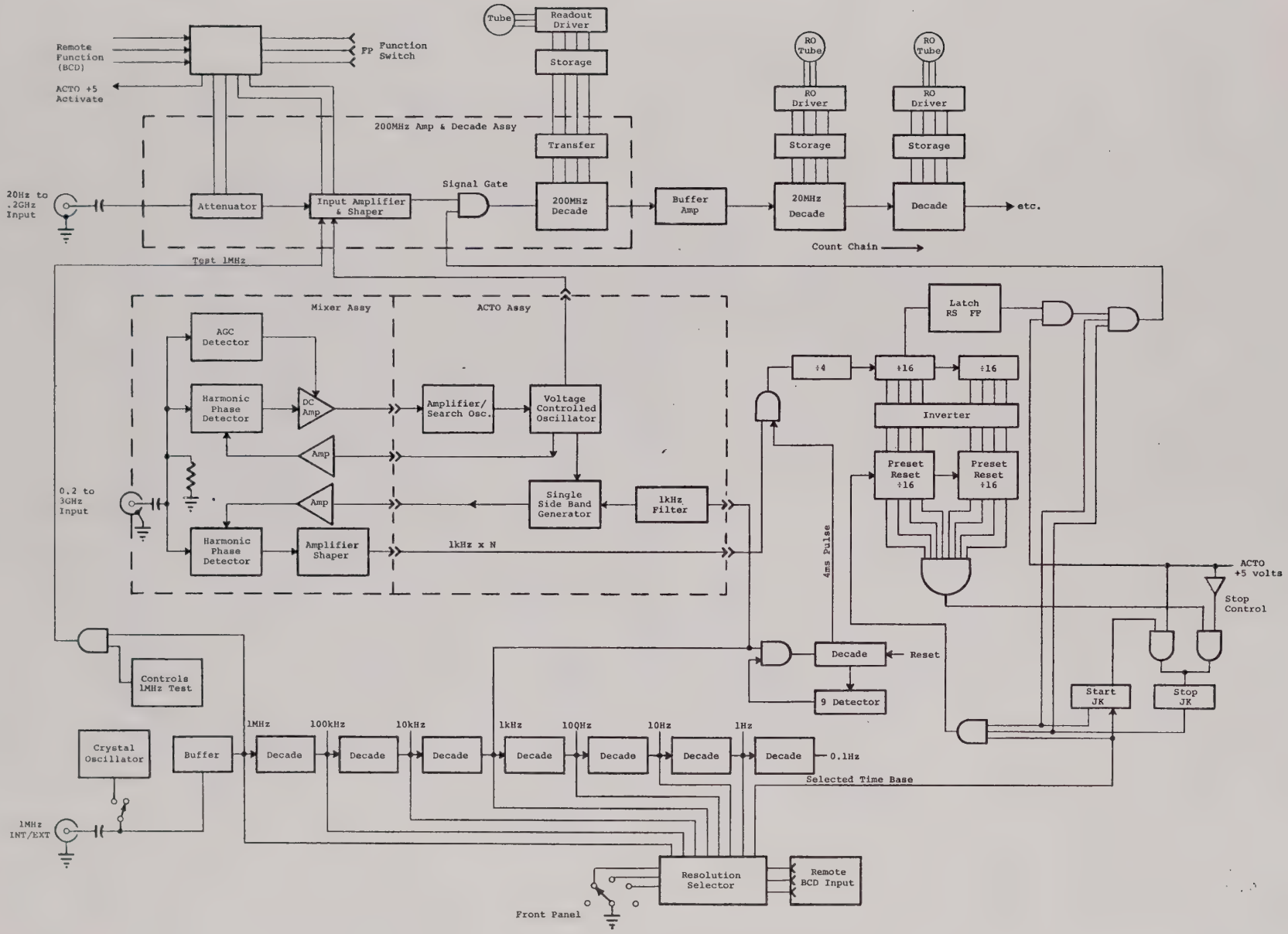


FIGURE 4.1 MODEL 6053/3 BLOCK DIAGRAM

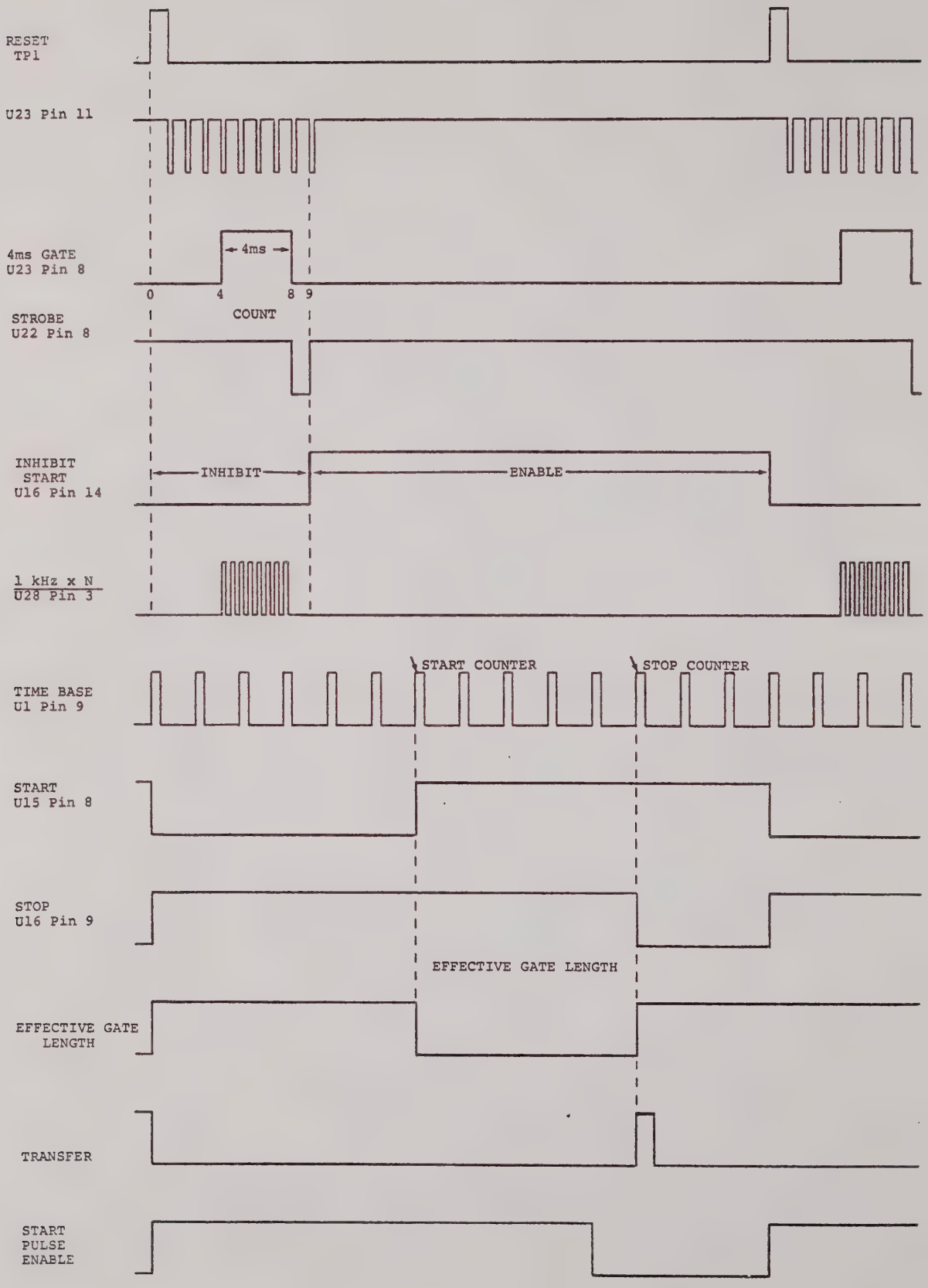


FIGURE 4.2 TIMING DIAGRAM, MODEL 6053/3

4.3.2 A2, SHIELD BOARD (Schematic D39100)

This circuit selects the various functions by pushbuttons located on the front panel. Refer to the Interconnect Diagram in Chapter 6.

4.3.3 A3, COUNTER READOUT ASSEMBLY (Schematic D03900001, Pages 1 and 2)

Included on this assembly are:

1. The time base count chain.
2. The resolution and function logic, both for internal and external BCD control.
3. The signal gate control circuitry.
4. The Count Chain.
5. The ACTO "N" computer circuitry.

1. Time Base Count Chain

The internal 1 MHz time base is applied to the count chain at terminal E42. This time base is derived from either an internal 6053 crystal-controlled oscillator or from an external standard.

It is first shaped by the Schmitt trigger Q1 and Q2; then, translated to TTL logic levels by Q3. It then drives U2 pin 14, the first decade in the counting chain. It is followed by U3, U4, U5, U6, U7 and U8, the remainder of the time base decades.

2. Resolution and function Logic

The outputs of the time base dividers become seven inputs of the two data selectors U1 and U9. Pins 9, 10 and 11 of these data selectors control, by BCD logic, which of the seven input time base frequencies will appear at U1 pin 5 as the selected time base frequency.

U1 normally selects the time base frequency and is BCD controlled by the 6053 front panel resolution switch. When this switch is turned to the remote position, however, it selects the eighth input, U1 pin 1 which is connected to the output of U9. U9, in turn, is controlled externally through its BCD inputs which connect to the remote control connector.

The following logic levels appear at the specified pins of the resolution switch giving both internal and remote switch positions.

TABLE 4.1 LOGIC STATES

Internal Pins	E4	E8	E9		
Remote Pins	E37	E39	E41	Decimal Point Position	Binary Number
Remote	0	1	1	-	3
100 kHz	0	0	0	4	0
10 kHz	0	0	1	5	1
1 kHz	0	1	0	6	2
100 Hz	1	0	0	4	4
10 Hz	1	0	1	5	5
1 Hz	1	1	0	6	6
0.1 Hz	1	1	1	7	7

The logic level at J5 if it is in the 1 state, drives U14 pins 1, 2 and 4 to the 1 state. Pin 3 of U15 goes to 0 and pin 6 of U15 goes to a 1 state. Pin 6 of U14 then goes to a 0 state turning Q6 off, extinguishing the GHz lamp and turning Q7 on; thus, supplying current to the MHz lamp.

A 0 at J5 has the opposite effect. By the presence of a 0 at U14 pin 4, U14 pin 6 is driven to a 1 state turning Q6 on, supplying current to the GHz lamp, turning Q7 off, extinguishing the MHz lamp.

Decimal Point

There are three decimal points in the GHz range and four decimal points in the MHz range. As seen from the chart they are positions 4, 5, 6 and 7. They are, with the exception of number 7, the same in the MHz range and in the GHz range. The decimal points are located in the display indicator and are switched by U29, a 4 to 10-line converter. The logic levels at the inputs of U29 are:

Indicator	A	B	C	D
4	0	0	1	0
5	1	0	1	0
6	0	0	1	0
7	1	1	1	0

Since the logic levels in the C and D columns do not change, they are permanently wired to the 1 and 0 logic levels. The logic levels at A and B are obtained from the terminal lugs, J3, J4 and are inverted by the two gate functions of U10, driving the 4 to 10-line converter U29 which lights the correct decimal point.

When the resolution switch is in the remote position, the decimal point logic is supplied to the external rear panel connector J5 through the other two gating elements of U10.

Function Switch

The front panel function switch is a set of six pushbuttons which supply BCD information to three sections of the quad gate U11. When the resolution switch is in "Remote", the 6053 functions are controlled by BCD from rear panel connector J5, operating the three sections of the Quad gate U12. The functions and BCD information required at lugs E31, E38 and E36; E33, E28 and E29 respectively are as follows:

TABLE 4.2 FUNCTION BCD

Remote	E33	E28	E29
Front Panel Control	E31	E38	E36
Test	1	0	0
Hi Frequency	0	0	0
X1	1	1	1
X10	0	1	1
X100	1	0	1
X1k	0	0	1

3. Signal Gate Control

The reset timing one shot U57 fires developing a positive pulse at the base of Q14. This is amplified and inverted by Q14 and turns Q15 off for the duration of the pulse. The positive pulse at the collector of Q15 resets all the counting decades, the 1 Hz and 0.1 Hz time base decades, as well as U26, U27 and U23. The positive pulse is inverted by U25 and then resets U16, U30; it is also available at pin E24.

U23, a decade counter, is normally driven by 1 kHz from U4, a time base divider, through the gate function U17. It will count the 1 kHz until the decade reaches the count of nine, at which time it drives the two input pins 4 and 5 of U22 to the 1 state. Pin 6 of U22 then becomes a 0 and disables U17, preventing any more 1 kHz pulses from reaching the input of U23. Pin 6 of U22 is inverted by U18. Pin 8 of U18 then becomes an inhibit-start signal for the stop flip-flop U16 by holding the

J line, pin 14, of U16 down in the 0 state. Pin 12 has been set to the 1 state by the negative reset pulse at pin 6 and pin 2.

The dual JK flip-flop is initially reset with pin 12 and pin 9 in the logical 0 state. (Low voltage state.) The voltage at pin 13 ($\overline{Q}$) is in the 1 state and is inverted by U17 to cause J (pin 7) to be in the 0 state preventing pin 8 (Q) from being driven.

Upon receipt of one of the time base pulses at pins 1 and 5, pin 12 is driven to the 1 state which permits the 6053 signal gate to open. At the same time pin 13 goes to the 0 state and after being inverted by U17, brings pin 7 (J input) to the 1 state.

The next time base pulse arriving at pins 1 and 5 cannot drive the left-hand flip-flop because pin 3 (K) is held in the 0 state and inhibits the flip-flop.

The time base does drive the right hand flip-flop (pin 5) causing pin 8 ($\overline{Q}$) to be in the 0 state. Pin 10 (J) is grounded so not further inputs will be accepted. Pin 8 now inhibits the signal gate and the 6053 count chain no longer has an input.

Transfer Pulse

When the right-hand flip-flop in U16 is driven, Q (pin 9) is driven to the 1 state. This is inverted by the gate function U11 after which it is differentiated by C4 and R24. It passes through CR2 and turns off Q10. A positive pulse appears at the collector of Q10 which transfers the BCD information contained in the count decades to the SN7475 storage packs.

The stored BCD now contained in the SN7475's is converted to 10 line information and drives the display indicators DS1 through DS9.

Reset

Pin 8 of U16 is coupled through R27 to the base of Q12. At the end of the count period Q12 turns off. This sets the timing one shot U57. A positive pulse is developed across R69 and coupled to the base of Q14. A reset pulse is generated which drives pin 8 of U16 positive, causing Q12 to turn on. Now the whole cycle repeats.

4. Count Chain

The count chain consists of U35,U38,U41,U44,U47,U50,U53 and U56. U35 is a SN7490, the remainder are SN7090 decades. The first decade in the count chain is not on the Read Out Board, but instead, is a separate assembly. In the 6053 the first decade is capable of counting up to 200 MHz. The input amplifier and signal gating circuits are included on the separate Amp and Decade Assembly.

The output of the first decade comes into the Readout Board at E18 and E19. The signal is amplified by Q4 and Q5; then drives the input (pin 14) of U35. Pin 11 of U35 couples to pin 14 of U38, and so on.

The BCD information enters the Readout Board at lugs E11, E12, E13 and E17 where it is stored in U32. The output of U32, when strobed by the control circuitry on pin 4 and 13, is translated to 10-line by U31 (SN7441). The output of U31, grounds one of the ten cathodes at the display indicator DS1 causing a number to glow.

The remaining storage packs (SN7475) are U34,U37,U40,U43,U46,U49,U52 and U55, and operate in the same manner.

5. ACTO Computer

The ACTO N computer causes the time base period selected by the front panel resolution switch to be expanded by some factor. Typically that factor will be the harmonic number "N".

When the 0.2-3 GHz button is pressed, lug E30 goes to near ground which enables the ACTO +5 V power supply. The ACTO +5 V enters the Readout Board at E44. It enables U17 pin 4 and, after being inverted by U18 pin 10 and 11, inhibits U17 pin 1. The effect of this is to prevent the stop flip-flop (U16 pin 9) from being driven until U19 pin 8 goes to the 0 state.

As shown in the timing diagram, the sequence of operation is inhibited by the reset pulse. The decade U23 is first reset to 0; then, counts the 1 kHz pulses until it reaches the count of 9, at which time U17 becomes disabled and the decade counts no further until the next reset pulse.

When the decade (U23) reaches the count of 4, pin 8 goes to the 1 state. This enables the gate U12 and raises the JK lines of U28, a dual JK flip-flop, to the 1 state. 1 kHz x N pulses are then divided by 4 in U28. The (1 kHz x N) divided by 4 is then counted by the two cascaded divide-by-16 counters U26 and U27 until U23 reaches the count of 8. At this time U12 is disabled and the JK lines of U28 are grounded. Since (1 kHz x N) divided by 4 has been counted for four periods of 1 kHz, N counts will be counted. When U23 reaches the count of 8, pin 1 of U20 and U21 go to the 0 state and return to the 1 state when U23 reaches the count of 9.

When strobed by a negative pulse on pin 1, the integrated divide-by-16 counters U20 and U21 are reset to the condition set up by the BCD inputs on pins 4, 10, 3 and 11.

The information contained in U26 and U27 is inverted so that a compliment of the BCD information is applied to the BCD input lines of U20 and U21.

If the number N is 34 then the compliment would be the full capacity of the two divide-by-16 minus 34.

When the decade reaches the count of nine, U16 pin 14 goes to the 1 state permitting a start pulse to be accepted. U15 pin 8 goes to the zero state. U15 pins 1, 2, 12 and 13 become enabled permitting the

time base pulses to pass through U15 to pin 8 of U20. U20 and U21 then continue to count the time base pulses, triggering on the trailing edge of the pulses. When U20 and U21 reach the condition 1111 or full capacity, pin 8 of U19 goes to the zero state. This occurs on the trailing edge of a timing pulse. This is inverted by U17 pin 4, 5 and 6 and enables pin 7 of U16 which permits the leading edge of the time base to drive the stop JK flip-flop. Pin 8 of U16 is driven to the zero state and inhibits U15. The preset divide-by-16 counters U20 and U21 no longer count the time base.

During the time that the divide-by-16 preset-reset counters are counting the time base, U15 pin 8, the start line, and U16 pin 9, the stop line are both near ground in the zero state. During this time the counting decades are counting the ACTO VCO frequency.

If N = 100 and the ACTO VCO frequency = 19 MHz, then the input frequency is 1900.0 MHz or 1.9 GHz and will be displayed by the 6053 display indicators.

4.3.4 200 MHz AND AND DECADE (Schematic D39095H)

The 200 MHz Amplifier and Decade circuit description consists of the following functions or circuits:

1. X100 Input Attenuator.
2. High input impedance, gain-controlled FET input stage.
3. Two stages of grounded emitter and two stages of emitter follower wideband amplification.
4. Schmitt trigger.
5. Count Gate.
6. 200 MHz ECL decade counter and ECL to TTL translator to provide TTL BCD output.

The front panel input to the 200 MHz Amplifier and Decade is capacitor coupled to the input attenuator. The attenuator is controlled by relay K1 to provide an attenuation factor of X1 or X100.

The output of the attenuator is applied to gate 1 (pin 2) of MOS FET Q2. Transistor Q2 provides a voltage gain of 2 or 0.2 which is controlled by the bias on gate 2 (pin 2), via transistor Q14.

Emitter follower Q3 dc couples the FET Q2 to a wideband amplifier comprised of transistors Q5 through Q8; providing two stages of grounded emitter and two stages of emitter follower amplification.

The emitter follower output of Q8 is applied to the Schmitt trigger circuit comprised of Q9 through Q12. Operational amplifier U1 functions as a voltage comparator by comparing the trigger level set by potentiometer R47 with the output at Q8's emitter. The difference at U1 output (pin 6) is applied to the base of Q1 via Q13 to provide feedback gain control to the FET input amplifier Q2; thus, setting the trigger level of the 200 MHz amplifier circuit.

Transistor Q1 also provides for the 1 MHz TEST input via connector J2 pin 4 and the 20 MHz ACTO input via coax connector J4. When either of these 2 inputs are applied, the front panel 200 MHz DIRECT input is disabled by biasing off FET Q2 via transistor Q15 by the application of an ENABLE level at connector J2 pin 2.

The gain of the 200 MHz amplifier circuit is set by potentiometer R50 to provide a gain of 2 when operating in the X1 attenuation mode. When X10 attenuation is selected a logic high is placed on connector J2 pin 3 which effects a gain of 0.2 by turning on transistor Q14. The Schmitt trigger output at the emitter of Q12 is applied to the count gate (U2 pin 10). The count gate is turned on and off by the START and STOP signals applied to connector J2 pin 8 and pin 9 respectively.

The first decade counter consists of U3 and U5. The bit 4 and bit 8 outputs are buffered by U2 and outputs via U2 pin 2 and 3 as the 1st DECADE ECL OUTPUT at J2 pins 5 and 6. The 1,2,4 and 8 BCD ECL logic levels are translated to TTL logic levels by U4 and outputs at connector J2 pins 14,11,13 and 12 respectively.

The first decade counter is reset by the application of a RESET signal on connector J2 pin 10 which resets U3 and U5 via transistors Q18 and Q19 which function as a TTL-to-ECL translator.

4.3.5. A5, ACTO (Schematic C39087)

The search oscillator generates the triangular waveform that sweeps the voltage-controlled oscillator (VCO). Transistors Q1 and Q2 form a binary switch. In the following example, with no input, (or with gain potentiometer R24 turned fully ccw) Q1 conducts and Q2 is held "off". Current flows from the -5.2 V supply, through Q1 and R9 into the input of amplifier U1 (pin 2). U1 inverts and, due to the feedback network (C2,R5) produces a linear rise in voltage at the output (pin 6). When the output voltage reaches +10 V (15 V difference of potential), CR1 conducts, forward biasing Q2. Q2 now conducts while Q1 is held "off". This action causes the amplifier (U1) to draw current from the positive supply through R12, driving the output in a negative direction until it reaches -5 V. At -5 V, Q2 is turned "off" and Q1 is turned "on", repeating the cycle. The net effect in a triangular waveform varying between +10 and -5 V (TP1).

Voltage-Controlled Oscillator ACTO

The triangular waveform is now applied to the base of emitter follower Q3, and into the voltage-controlled oscillator's (VCO) frequency determining tank circuit (CR3, CR4 and L2). CR3 and CR4 are "varicap" type diodes whose capacitance is inversely proportional to the bias applied.

Note that, the varicap curve is nonlinear. To compensate for this nonlinearity, correct networks consisting of a resistor and a diode in series (R6,CR2 and R3,CR8) are placed across the triangular wave generator load resistor, R15. The effect of these 2 networks is a nonlinear curve which opposes the varicap curve, resulting in a more linear function.

Single-Sideband Generator

The output from the VCO must be shifted in frequency by 1 kHz in order to properly drive the "N" channel harmonic mixer, and must be sinusoidal to drive the single-sideband generator.

The VCO signal is obtained from the emitter of Q5, filtered by R23,C31, L6 and C32 to reduce harmonic distortion, and is then split into two components, separated in phase by 90°. Phase separation is accomplished by an LR phase lag circuit (L7,R50) and CR phase lead circuit (C19,R49). The resultant signals are used to drive balanced modulators (U2).

Simultaneously, a 1 kHz signal from the time base is routed to the base of Q10. Transistor Q10 inverts and amplifies the signal. A "twin T notch filter" on the collector of Q10 is tuned to block 1 kHz, passing all other frequencies. Q11 FET transistor provides a negative feedback path for all frequencies except 1 kHz. The remaining 1 kHz signal, at the collector of Q10, is now capacitively coupled to the base of phase-splitting amplifier Q8. Two separate 1 kHz signals, 90° out-of-phase, are extracted from Q8; the non-inverted signal signal from the emitter circuit and the 90° leading signal from the emitter of Q9. These signals are capacitively coupled to the balanced modulators in U2. The first balanced modulator removes the carrier frequency, and the second modulator removes 1 sideband resulting in a single-sideband signal. The net effect of this action is the shifting of the carrier frequency by 1 kHz. The balanced modulators (U2) are a pair of differential amplifiers utilizing the carrier to drive the common mode inputs. U3 sums the outputs of the balanced modulators and converts them to a single output.

4.3.6 A6, ACTO MIXER/DRIVER (Schematic C27988)

The Mixer/Driver Assembly consists of two sampling-type mixers, including the local oscillator drive circuits and output amplifiers.

The output of the ACTO VCO is applied to terminal A on the Driver Amp. It is amplified by the differential amplifier/limiter Q101 and Q102. With signal applied, Q105 emitter follower in turn drives the anode of step recovery diode CR101 positive, charging capacitor C107. When the voltage tries to reverse, the diode CR101 continues to conduct for a time. When it finally reverses, it does so very abruptly. Since all of the current through CR101 has been passing through the printed circuit inductors a voltage transient develops when the current is no longer available. A negative pulse is formed at the anode of CR101 and a positive pulse at the cathode of CR101. These two pulses are approximately 1.2 V in amplitude and 0.5 nsec in width at the base line. They are coupled through C101, X1, P1 and C102 X2, P2 to the Mixer Assembly.

This has been a description of the lock channel driver. The N channel driver (Q103, Q104 and CR106) operates in exactly the same manner.

Sampling Bridge

The negative pulse from P1 is terminated in R1; then, coupled through C1 to the cathode of CR2.

The positive pulse from P2 is terminated in R2; then, coupled through C2 to the anode at CR1. CR1 and CR2 detect these pulses and set up a positive 0.7 V bias on the cathode of CR2 and negative bias on the anode of CR1. The voltage at the junction of R5 and R6 is nominally 0 V dc.

The second sampling bridge CR3, CR4, R7 and R8 operates identical to the first.

The RF input signal (200 MHz to 3 GHz) is applied to the input of both sampling bridges (junction of CR1, CR2 and junction of CR3, CR4). It is then terminated into R9, a 50 Ω chip resistor.

The output of the lock phase detector bridge is amplified by U1, an operational amplifier. The dual FET Q1 is used as source followers to reduce the signal input current requirement by the amplifier. The output of the amplifier is present at lug "C" on the Mixer PC board.

To improve the dynamic range of the ACTO and the overload characteristic, an AGC system is used.

CR5 is used as an AGC Detector and detects the level of RF applied to the input of the instrument. The dc voltage drop across CR5 is cancelled out by an opposing voltage drop across CR6. The detected dc voltage is then amplified by the operational amplifier U2. A negative voltage is developed on the output of this amplifier and biases Q3, an N channel FET. Q3 is used as a voltage-controlled resistor which, by altering the negative feed-back, controls the gain of the lock channel amplifier U1.

The dc feed-back network around U2 is designed to have nonlinear gain curve which matches the voltage to resistance curve of Q3. Potentiometer R19 determines the AGC operating threshold voltage. The output of U1 on Mixer PC Board goes out to lug "C"; then, through the connecting cable to pin 14 of J2 on the ACTO assembly. There is connects to the input of U1, the search oscillator/amplifier.

When in a phase lock condition, a voltage appears at pin 14, J2 which cancels the current supplied by R9 to pin 2 of U1. Then the search oscillator is over-powered and U1 becomes simply an amplifier.

The N channel amplifier/shaper consists of Q2 and U3. Q2 is a source follower which presents a high impedance load to the N channel phase detector (actually used as a mixer).

Transistor Q2 is followed by an emitter follower; then, a grounded base stage. The output of the grounded base stage drives the Schmitt trigger. The shaped output from the Schmitt trigger drives the grounded emitter amplifier. This last amplifier provides square waves at terminal "X", at TTL logic levels. All the amplifying and shaping is done with five transistors in U3, a transistor array.

The signal at terminal "X" is 1 kHz x N. The input of the Schmitt trigger (pin 4 of U3) goes to a lug TP1 and is available as 1 kHz x N prior to shaping.

CHAPTER 5

CALIBRATION-MAINTENANCE

5.1 INTRODUCTION

This chapter is devoted to maintaining the factory-new performance of the Model 6053 Counter. A calibration procedure, acceptance test and troubleshooting guide have been included for this purpose.

5.2 FACTORY SERVICE

Whenever the instrument requires service, other than normal calibration, the nearest Systron-Donner representative should be contacted. He can provide field service or arrange factory service when necessary. Address all inquires on operation or application to your nearest sales representative, or to:

Sales Manager-Concord Instrument Division
Systron Donner Corporation
2727 Systron Drive
Concord, California 94520

Be sure to specify the complete model and serial number in all correspondence.

5.3 PART LOCATION

Printed circuit board outline drawings and related parts lists have been included in Chapter 6 to facilitate part identifications and location.

5.4 CALIBRATION PROCEDURE

The following test equipment is required for calibration and adjustments:

(1)	Oscilloscope	Tektronix	Model 581A or equivalent
(2)	Voltmeter	Systron Donner	Model 9000 or equivalent
(3)	Voltmeter	Simpson	Model 260 or equivalent
(4)	1 MHz frequency standard; 1 part in 10^{-10} short term		
(5)	Signal Generator	H.P.	Model 608E or equivalent
(6)	RF Voltmeter	H.P.	Model 411A or equivalent

5.4.1 Power Supply Adjustments (Schematic 05362301)

The following chart indicates the proper supply voltages. There are no voltage adjustments in the power supply. Voltages must be within the following tolerance when measured at the designated points on assembly 05362301.

TABLE 5.1 POWER SUPPLY ADJUSTMENT

Location	Voltage	Tolerance
E20	+15.00	±0.7 V dc
E23	+5.00 ACTO +5	±0.25 V dc
E24	+5.00	±0.7 V dc
E27	-15	±0.7 V dc
E31	-5.20	±0.7 V dc

5.4.2 Oscillator Adjustment

Push on TEST pushbutton. Place 1 MHz INT/EXT switch to INTernal. With oscilloscope (1), triggered by the 1 MHz (4) frequency standard; monitor the 1 MHz IN-OUT BNC for a 2.5 V peak-peak (minimum amplitude) 1 MHz rectangular wave. Set COARSE frequency adjustment (counter rear panel) to a position which results in most stationary waveform on scope. Set FINE frequency adjustment (optional oscillators) to position which results in most stationary waveform on scope. Place 1 MHz INT-EXT switch to EXT. Oscilloscope should no longer display 1 MHz signal. Remove calibration equipment.

5.4.3 200 MHz Input Amp and Decade Adjustment (Schematic D39095)

1. Push the power switch on and press the X1 ATTENUATOR button.

2. Apply 200 MHz at a level of 10 mV. This is measured at the front panel as shown in Figure 5.1.

3. With the Resolution switch in 100 kHz position, adjust R47 to obtain a good stable reading. Reduce the input level, and repeat the adjustment to find the optimum setting.

4. Note the input voltage level that is required for a stable reading. Increase this level by a factor of ten.

5. Press the X10 ATTENUATOR button and adjust R50 until the 6053 just barely counts correctly. Reduce the input level and then increase it to the original X10 level. The 6053 should again present a stable correct reading. The level required should not exceed 100 mV.

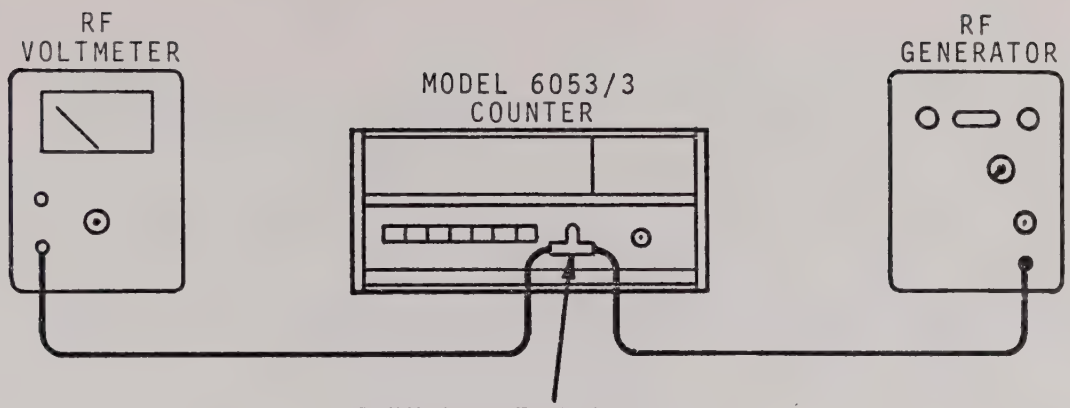


FIGURE 5.1 VOLTAGE MEASUREMENT OF RF INPUT

6. Press the X100 ATTENUATOR button; then, increase the generator output level another factor of ten. Verify that a stable and correct indication is present. If not, repeat 5.4.3.

5.4.4 ACTO ADJUSTMENT

Mixer Balance

1. With no input connected to the 6053, press the .2-3 GHz button.

2. Observe the waveform present at TP1 on the ACTO Assembly (A5). This should be a symmetrical triangular waveform swinging between +10 and -5 volts.

3. Adjust R17 on the Mixer Assembly (A6), if necessary, to make the waveform symmetrical.

4. Apply 3 GHz to the 0.2-3 GHz input at a level of -15 dBm. Set R19 for a voltage of -1.75 to -2.00 V dc measured at Pin 6 of U2.

Gain Set

1. Set the resolution switch to 10^{-3} (1 kHz) or 10^{-4} (10 kHz) resolution.

2. Apply 3 GHz at a level of 50 mV rms (-13 dBm) to the .2-3 GHz input of the 6053.

3. Adjust the gain control R24 on the ACTO Assembly (A5), so that 6053 correctly indicates the input frequency.

5.5 BOARD REPAIR

NOTE

Read before changing any component on a printed-circuit board.

When replacing integrated circuits or other electronic components soldered to printed-circuit boards, the procedures indicated below must be followed or damage to the board may result:

1. Determine by troubleshooting techniques, which integrated circuit or discrete component(s) has failed.

2. Remove the defective component(s) from the board by cutting the pins or leads with a small diagonal clipping tool. (Always remove and replace the ;entire component.)

3. Apply heat (40-50 W soldering iron) sparingly to each of the cut pins or leads and remove from the board; clean the hole(s) with a toothpick or solder suction tool.

4. Form the tinned leads of the replacement part and insert in the printed circuit holes; solder, then trim leads to extend 1/16-inch beyond the back surface of the board. (Use only 63-37 solder with maximum 1/16-inch diameter.)

CAUTION

Always trim semiconductor leads only after soldered installation is complete. This procedure greatly lessens the possibility of component failure due to shock-wave damage caused by the trimming tool.

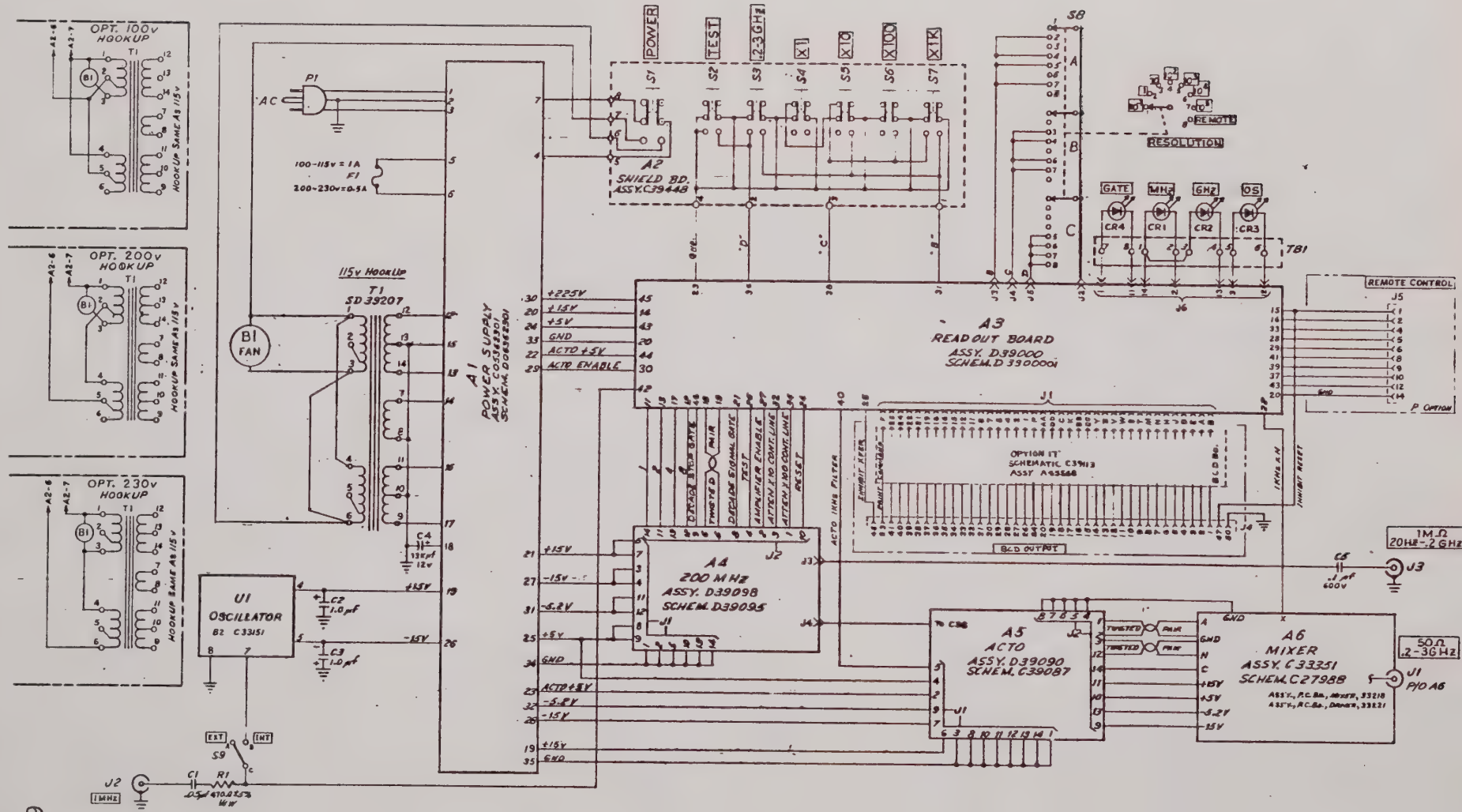
5. When soldering semiconductor devices and all small components, be sure to use a heat sink tool or long-nosed plier connected to the component lead(s) while each is being soldered. Allow the soldered connection to cool before removing the heat sink.

6. Clean all dirt and solder-flux from the printed circuit traces by liberal application of isopropyl alcohol or freon-type solvents.

CHAPTER 6
DRAWINGS AND PARTS LISTS

6.1 INTRODUCTION

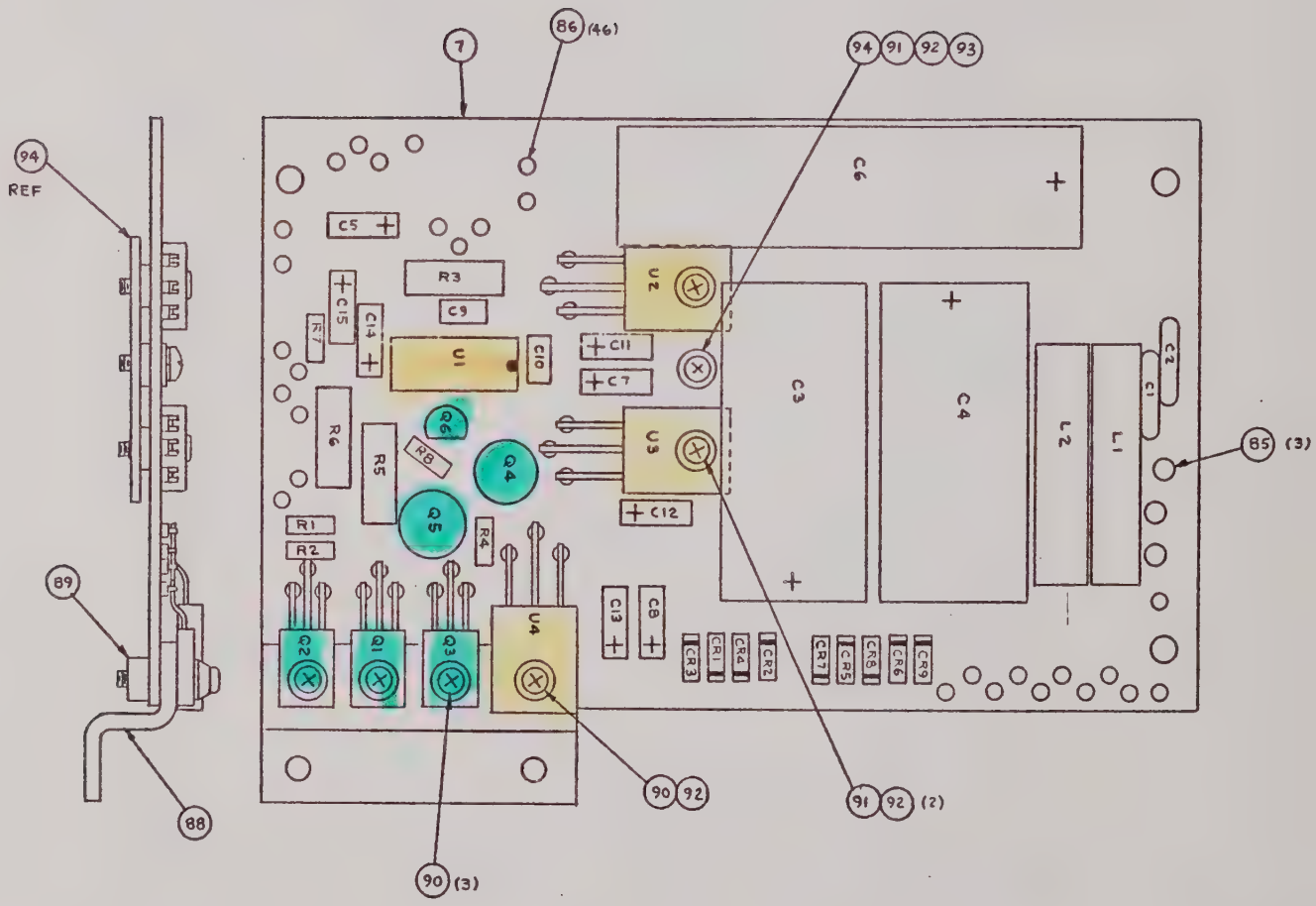
This chapter contains the drawings and parts list for the SD Model 6053 Frequency Counter. Each section is composed of an assembly, schematic, and a parts list. All sections are arranged in assembly sequence, with the exception of the Block Diagram, and the Block Diagram Parts List - these items follow immediately after this introduction.



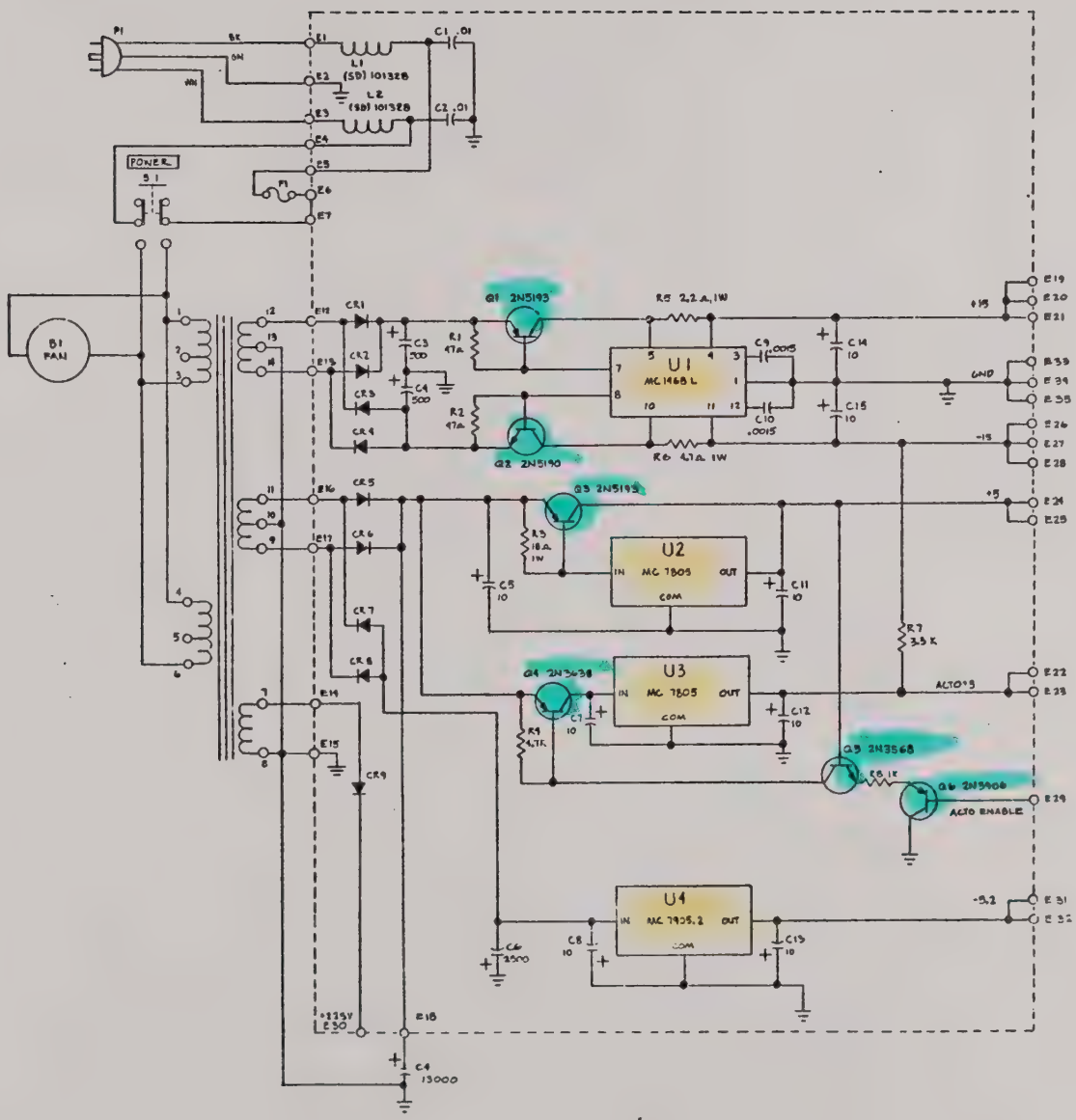
MODEL 6053/3 INTERCONNECT DIAGRAM, D3900001

FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Block Diagram, Model 6053/3	D39100R3
B1	Blower	H1786
C1	Capacitor, .05 µF, 12 V	C0672
C2	Capacitor, 1.0 µF, 35 V	C0524
C3	Capacitor, 1.0 µF, 35 V	C0524
C4	Capacitor, 13 KµF, 12 V	C1122
C5	Capacitor, .1 µF, 600 V	03285090
CR1	Assembly Lamp, Light Emitting SL1171	CR0367
CR2	Assembly Lamp, Light Emitting SL1171	CR0367
CR3	Assembly Lamp, Light Emitting SL1171	CR0367
CR4	Assembly Lamp, Light Emitting SL1171	CR0367
F1	Fuse, 1A, 3AG	F0001
J1	Connector, Female, Type N	J0552
J2	Connector, BNC	J0165
J3	Connector, BNC	J0260
J4	Connector, 50 Pin	J0170
J5	Connector, 14 Pin	J0310
P1	Line Cord	W0088
R1	Resistor, 470 Ω, 1/4W, 5%	R1044
S8	Assembly switch, Resolution	39451
S9	Switch, Toggle, SPDT	S0149
T1	Transformer	39207
U1	Oscillator	33151
	Filter, Polaroid	33922
	Filter, Foam	39410
	Fuse Holder	X0034
	Knob	H1937
	Socket, Octal	X0004
	Acto Cable Assy	39469
	Acto Mixer, Cable Assy	29475
	Connector, IC	J0605
	Recept. AMP 60939-1	J0607



A1, POWER SUPPLY ASSEMBLY, C05362301



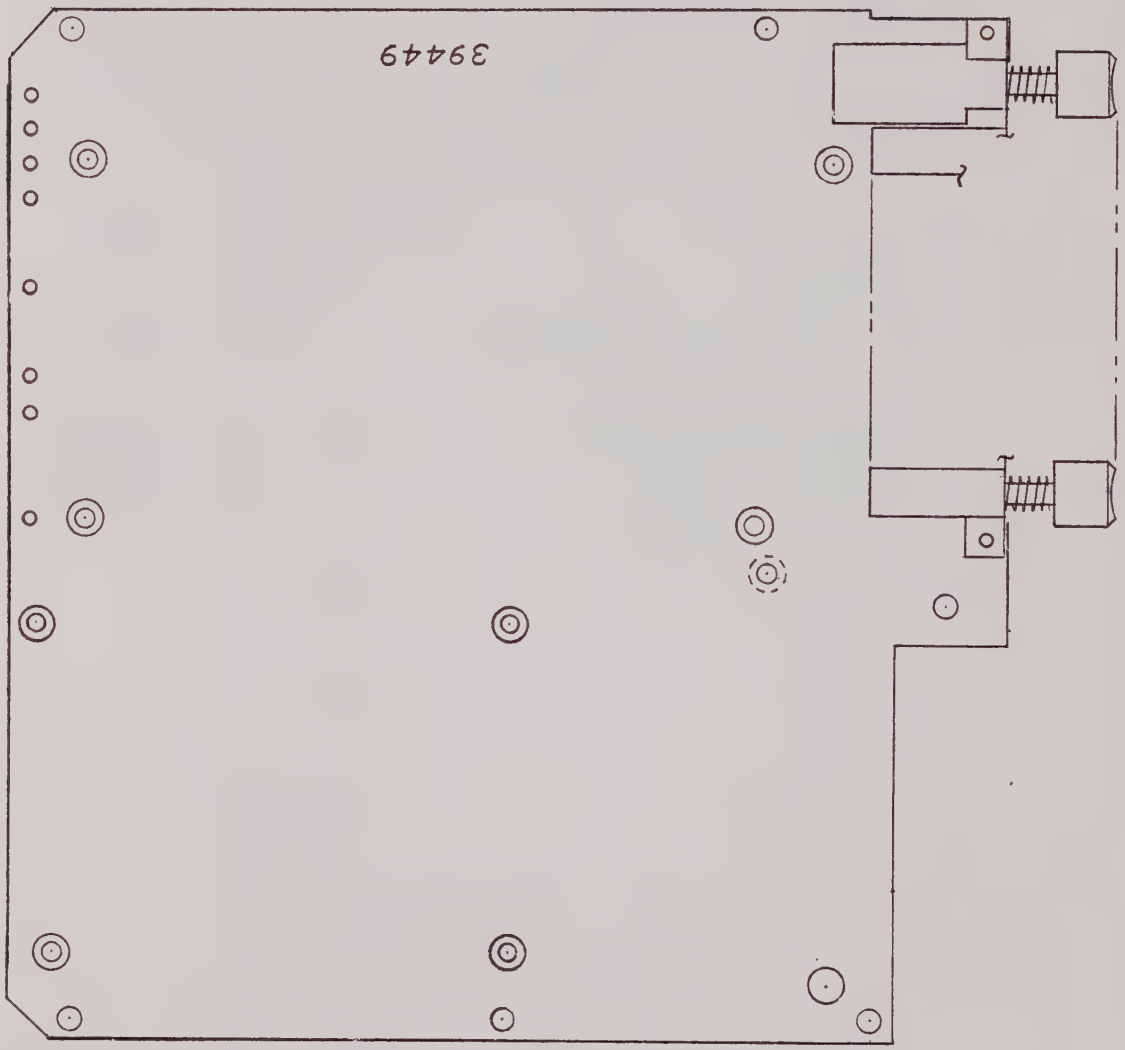
A1, POWER SUPPLY SCHEMATIC, D05362301

A1 POWER SUPPLY ASSEMBLY

Ref.	Description	SD Part No.
	A1 Power Supply P.C. Assembly	C05362301
	A1 Power Supply Schematic	D05362301
C1	Capacitor, .01 µF 500 V Disc	100075
C2	Same as C1	
C3	Capacitor, 500 µF 50 V ElAx	100296
C4	Same as C3	
C5	Capacitor, 10 µF 20 V Tant	100063
C6	Capacitor, 2500 µF 15 V ElAx	100247
C7	Same as C5	
C8	Same as C5	
C9	Capacitor, .001 µF Mylar	100198
C10	Same as C9	
C11	Same as C5	
C12	Same as C5	
C13	Same as C5	
C14	Same as C5	
C15	Same as C5	
CR1	Diode, 1N4005	100413
CR2	Same as CR1	
CR3	Same as CR1	
CR4	Same as CR1	
CR5	Same as CR1	
CR6	Same as CR1	
CR7	Same as CR1	
CR8	Same as CR1	
CR9	Same as CR1	
L1	Inductor, Line Filter	101328
L2	Same as L1	
Q1	Transistor, 2N5193	101405
Q2	Transistor, 2N5190	101394
Q3	Same as Q1	
Q4	Transistor, 2N3638	101360
Q5	Transistor, 2N3568	101359
Q6	Transistor, 2N3906	101378
R1	Resistor, 47 Ω 5%, 1/4 W	101560
R2	Same as R1	
R3	Resistor, 18 Ω 5%, 1/4 W	106022
R4	Resistor, 4.7 k 5%, 1/4 W	101598
R5	Resistor, 2.2 Ω 5%, 1 W	103031

A1 POWER SUPPLY ASSEMBLY (Cont'd)

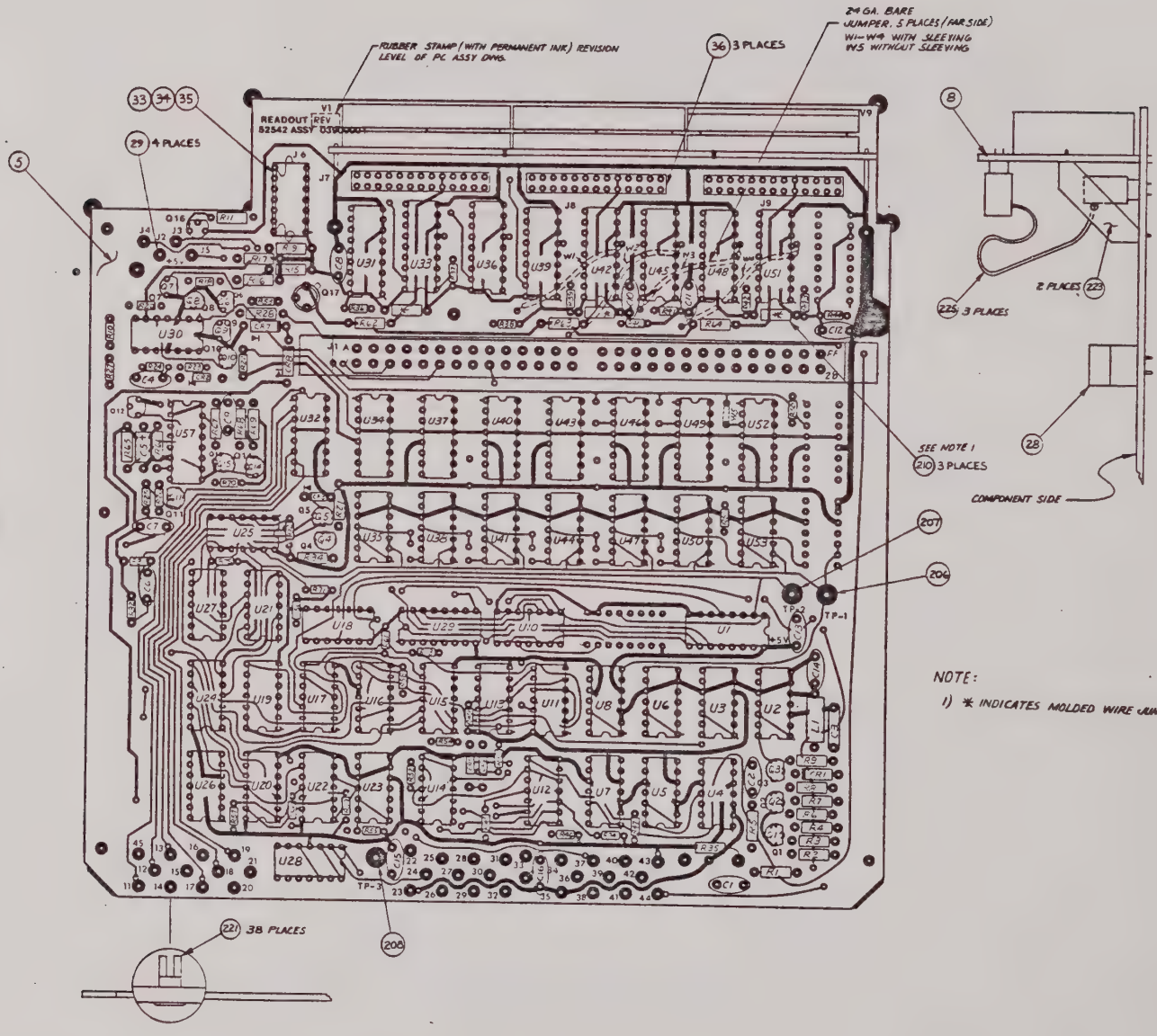
Ref.	Description	SD Part No.
R6	Resistor, 4.7 Ω 5%, 1 W	101678
R7	Resistor, 3.3 k 5%, 1/4 W	101559
R8	Resistor, 1 k 5%, 1/4 W	101569
U1	Integrated Circuit, MC1468L	045253
U2	Integrated Circuit, MC7805CP	045256
U3	Same as U2	
U4	Integrated Circuit, MC7905.2CP	103033
85	Terminal Lug	100508
86	Terminal Lug	100482
87	Not Used	
88	Power Transistor Heat Sink	053633
89	NUT, Plate (Pass Transistors)	053734
90	SCREW, 4-40 x 7/16 PHM	10062607
91	SCREW, 4-40 x 5/16 PHM	10062605
92	WASHER, No. 4 Split	100711
93	WASHER, No. 4 Flat	100703
94	NUT, Plate (MC7805CP's)	055219



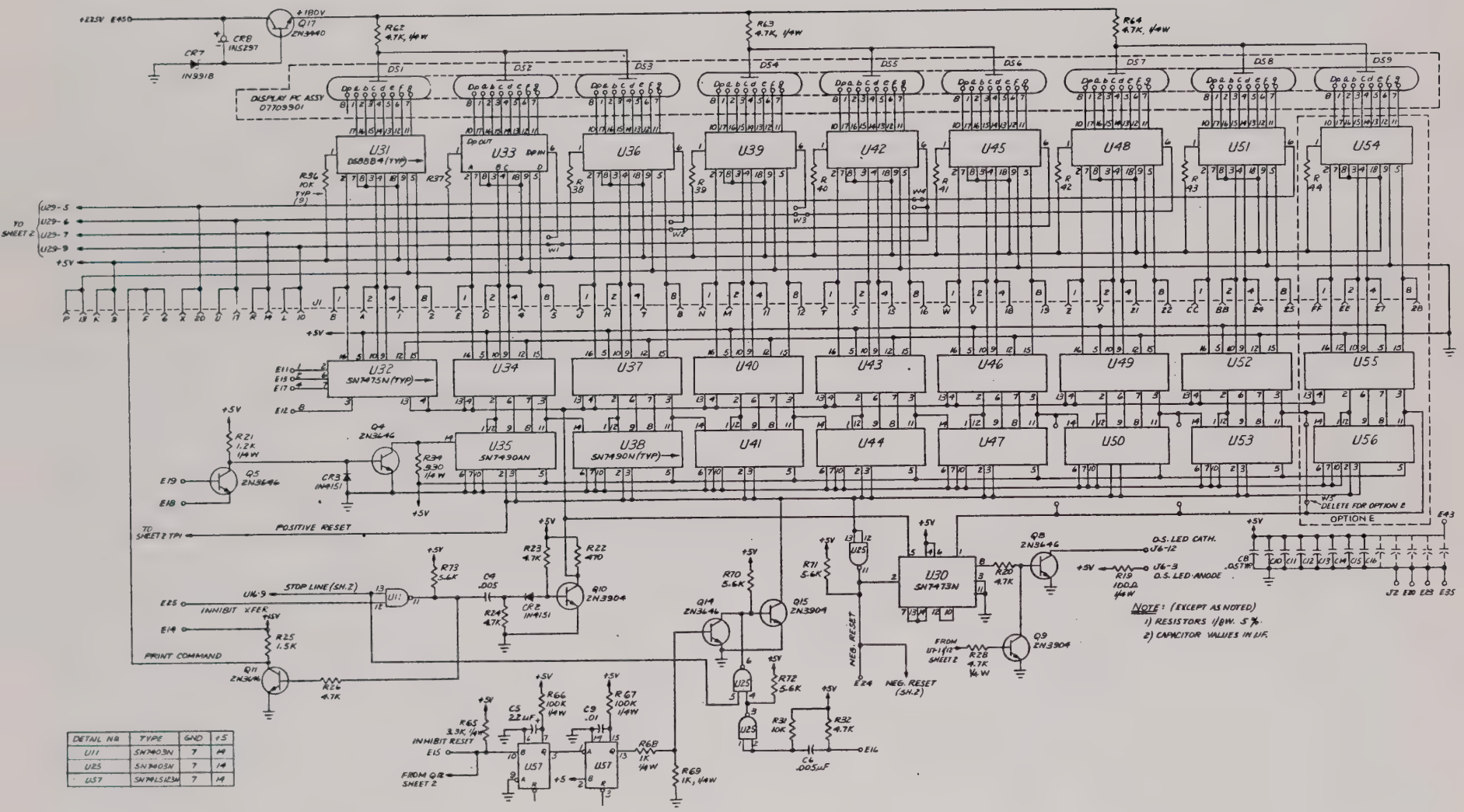
A2, SHIELD BOARD ASSEMBLY, C39448R2

A2 SHIELD PARTS LIST

REF.	DESCRIPTION	SD PART NO.
	A2 Shield P.C. Assembly	C39448R2
	A2 Shield Schematic	P/O D39100R3
S1	Switch, Pushbutton, 7 STA W/Buttons	S0392
S2	Switch, Pushbutton, 7 STA W/Buttons	S0392
S3	Switch, Pushbutton, 7 STA W/Buttons	S0392
S4	Switch, Pushbutton, 7 STA W/Buttons	S0392
S5	Switch, Pushbutton, 7 STA W/Buttons	S0392
S6	Switch, Pushbutton, 7 STA W/Buttons	S0392
S7	Switch, Pushbutton, 7 STA W/Buttons	S0392

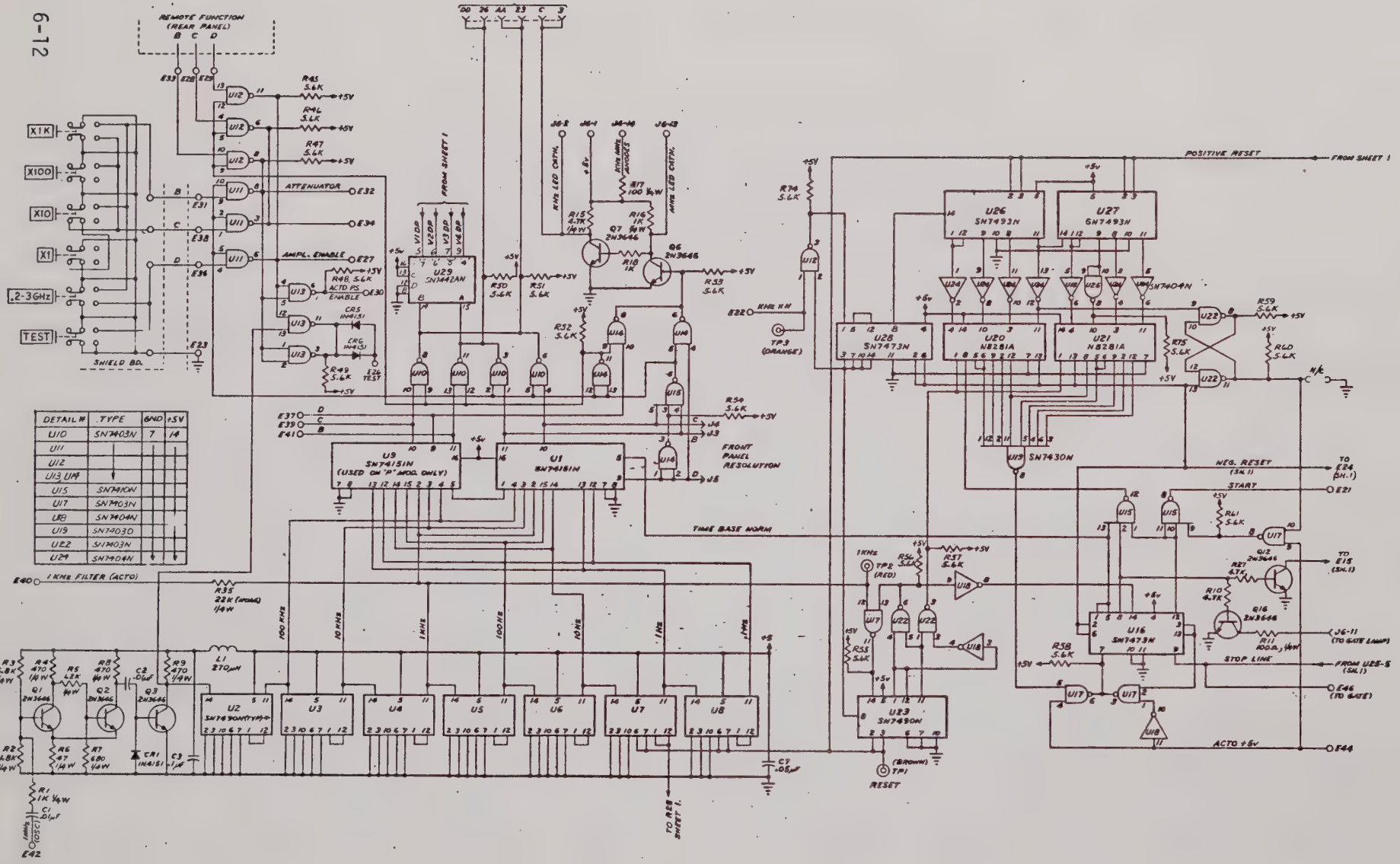


A3, READOUT P.C. ASSEMBLY, D3900001



DETAIL NO	TYPE	GND	+5
U11	SN7403N	7	14
U25	SN7403N	7	14
U57	SN74LS123N	7	14

A3, READOUT SCHEMATIC, SHEET 1 of 2, D3900001



DETAIL #	TYPE	GND	+5V
U10	SN7403N	7	14
U11			
U12			
U13, U14			
U15	SN7430N		
U17	SN7403N		
U18	SN7404N		
U19	SN74030		
U22	SN7403N		
U24	SN7404N		

A3, READOUT SCHEMATIC, SHEET 2 of 2, D3900001

A3 READOUT BOARD PARTS LIST

Ref.	Description	SD Part No.
	A3 Readout Board P.C. Assembly	D03900001
	A3 Readout Board Schematic	D03900001
A1	Assembly, Display	C07709901
C1	Capacitor, .01 µF, 100 V	100103
C2	Same as C1	
C3	Capacitor, .1 µF, 50 V	100178
C4	Capacitor, .005 µF, 150 V	100058
C5	Capacitor, 2.2 µF, 20 V	100203
C6	Same as C4	
C7	Capacitor, .05 µF, 12 V	100122
C8	Same as C7	
C9	Same as C1	
C10	Same as C7	
C11	Same as C7	
C12	Same as C7	
C13	Same as C7	
C14	Same as C7	
C15	Same as C7	
C16	Same as C7	
CR1	Diode, 1N4151	100385
CR2	Same as CR1	
CR3	Same as CR1	
CR4	Not Used	
CR5	Same as CR1	
CR6	Same as CR1	
CR7	Diode, 1N991B	100461
CR8	Diode, 1N5297	100457
J1	Connector, P.C. 28/56	102638
J2	Connector, Post	100562
J3	Same as J2	
J4	Same as J2	
J5	Same as J2	
J6	Connector, Socket, IC 14 Terminal	102433
L1	Inductor, 270 µH	101302
Q1	Transistor, 2N3646	101369
Q2	Same as Q1	
Q3	Same as Q1	

Ref.	Description	SD Part No.
Q4	Same as Q1	
Q5	Same as Q1	
Q6	Same as Q1	
Q7	Same as Q1	
Q8	Same as Q1	
Q9	Transistor, 2N3904	101377
Q10	Same as Q9	
Q11	Same as Q1	
Q12	Same as Q1	
Q13	Not Used	
Q14	Same as Q1	
Q15	Same as Q9	
Q16	Same as Q1	
Q17	Transistor, 2N3440	101420
R1	Resistor, 1 k 5%, 1/4 W	101569
R2	Resistor, 1.8 k 5%, 1/4 W	101602
R3	Resistor, 6.8 k 5%, 1/4 W	101544
R4	Resistor, 470 Ω 5%, 1/4 W	101625
R5	Resistor, 1.2 k 5%, 1/4 W	101581
R6	Resistor, 47 Ω 5%, 1/8 W	101560
R7	Resistor, 680 Ω 5%, 1/8 W	101669
R8	Same as R4	
R9	Same as R4	
R10	Resistor, 4.7 k 5%, 1/8 W	101792
R11	Resistor, 100 Ω, 5%, 1/4 W	101609
R12	Not Used	
R13	Not Used	
R14	Not Used	
R15	Resistor, 4.7 k 5%, 1/4 W	101598
R16	Same as R1	
R17	Same as R11	
R18	Resistor, 1 k 5%, 1/8 W	
R19	Same as R11	
R20	Same as R10	
R21	Same as R5	
R22	Resistor, 470 Ω 5%, 1/8 W	101709
R23	Same as R10	
R24	Same as R10	
R25	Resistor, 1.5 k 5%, 1/8 W	101974

A3, READOUT BOARD PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R26	Same as R10	
R27	Same as R10	
R28	Same as R15	
R29	Not Used	
R30	Not Used	
R31	Resistor, 10 k 5%, 1/8 W	101697
R32	Same as R10	
R33	Not Used	
R34	Resistor, 330 Ω 5%, 1/4 W	101536
R35	Resistor, 22 k 5%, 1/4 W	101572
R36	Same as R31	
R37	Same as R31	
R38	Same as R31	
R39	Same as R31	
R40	Same as R31	
R41	Same as R31	
R42	Same as R31	
R43	Same as R31	
R44	Same as R31	
R45	Resistor, 5.6 k 5%, 1/8 W	101715
R46	Same as R45	
R47	Same as R45	
R48	Same as R45	
R49	Same as R45	
R50	Same as R45	
R51	Same as R45	
R52	Same as R45	
R53	Same as R45	
R54	Same as R45	
R55	Same as R45	
R56	Same as R45	
R57	Same as R45	
R58	Same as R45	
R59	Same as R45	
R60	Same as R45	
R61	Same as R45	
R62	Same as R15	
R63	Same as R15	
R64	Same as R15	
R65	Resistor, 3.3 k 5%, 1/4 W	101569

A3, READOUT BOARD PARTS LIST (Cont'd)

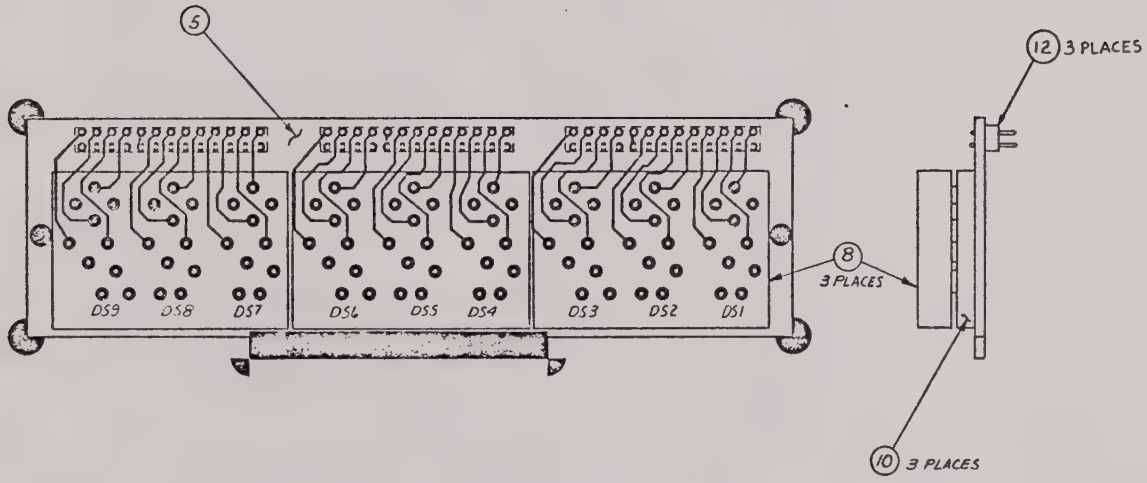
Ref.	Description	SD Part No.
R66	Resistor, 100 k 5%, 1/4 W	101558
R67	Same as R66	
R68	Same as R1	
R69	Same as R1	
R70	Same as R45	
R71	Same as R45	
R72	Same as R45	
R73	Same as R45	
R74	Same as R45	
R75	Same as R45	
TP1	Test Point, Brown	100546
TP2	Test Point, Red	100541
TP3	Test Point, Orange	100544
U1	Integrated Circuit, SN74151N	025771
U2	Integrated Circuit, SN7490N	025732
U3	Same as U2	
U4	Same as U2	
U5	Same as U2	
U6	Same as U2	
U7	Same as U2	
U8	Same as U2	
U9	Not Used	
U10	Integrated Circuit, SN7403N	103218
U11	Same as U10	
U12	Same as U10	
U13	Same as U10	
U14	Same as U10	
U15	Integrated Circuit, SN7410	019706
U16	Integrated Circuit, SN7473N	019709
U17	Same as U10	
U18	Integrated Circuit, SN7404N	025779
U19	Integrated Circuit, SN7430N	025727
U20	Integrated Circuit, SN8281A	
U21	Same as U20	
U22	Same as U10	
U23	Same as U2	
U24	Same as U18	
U25	Same as U10	
U26	Integrated Circuit, SN7493N	025715
U27	Same as U26	

A3, READOUT BOARD PARTS LIST (Cont'd)

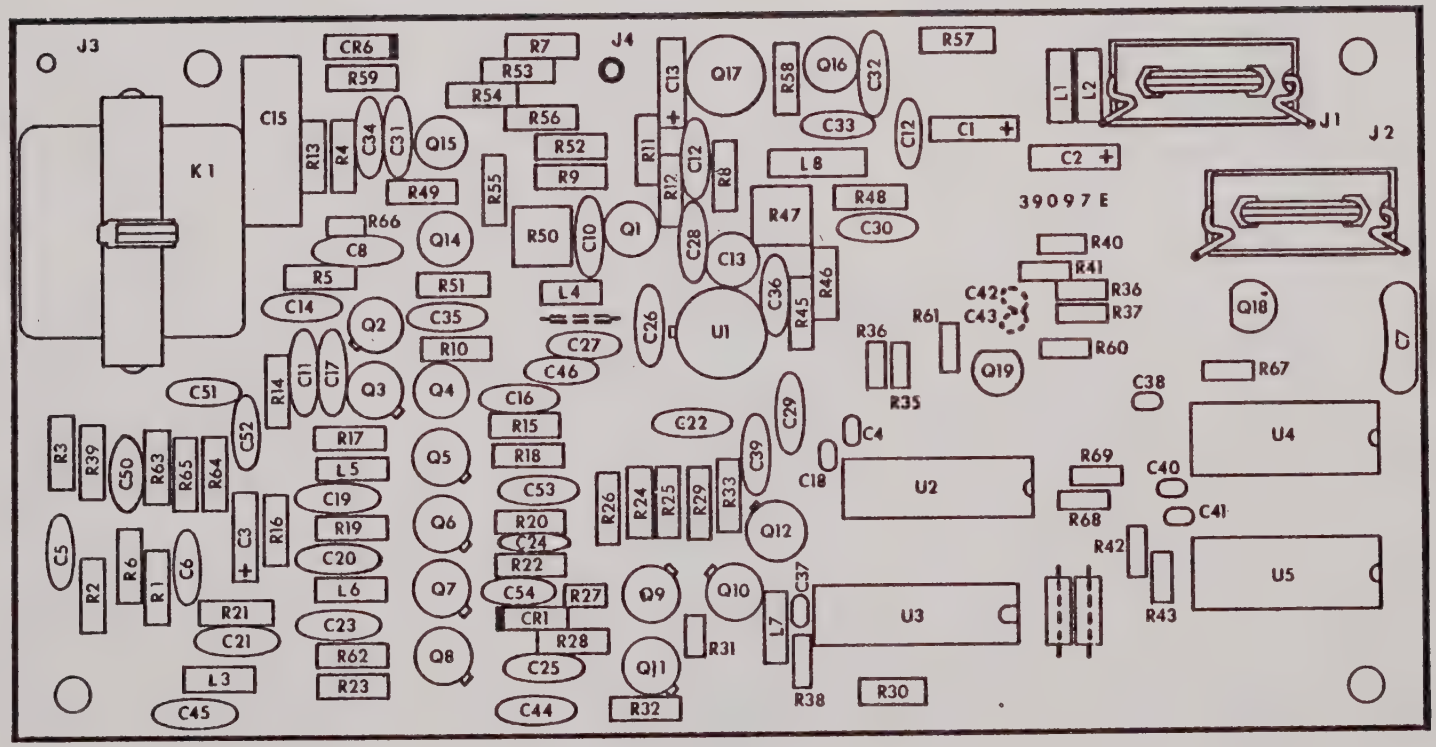
Ref.	Description	SD Part No.
U28	Same as U16	
U29	Integrated Circuit, SN7442AN	025749
U30	Same as U16	
U31	Integrated Circuit, DS8884	103230
U32	Integrated Circuit, SN7475N	019710
U33	Same as U31	
U34	Same as U32	
U35	Integrated Circuit, SN7490AN	019711
U36	Same as U31	
U37	Same as U32	
U38	Same as U2	
U39	Same as U31	
U40	Same as U32	
U41	Same as U2	
U42	Same as U31	
U43	Same as U32	
U44	Same as U2	
U45	Same as U31	
U46	Same as U32	
U47	Same as U2	
U48	Same as U31	
U49	Same as U32	
U50	Same as U2	
U51	Same as U31	
U52	Same as U32	
U53	Same as U2	
U54	Not Used	
U55	Not Used	
U56	Not Used	
U57	Integrated Circuit, SN74LS123N	103976
XJ6	Retainer, Plug	039976
XJ6	Insulator, 14-hole	100993
	Jumper, Molded	102879
	Header, 2x13	117340
	Terminal	100482
	Bracket, Display and Driver Board	051450
	Assembly, Cable Flat	07722401

A3A1, DISPLAY PC ASSEMBLY

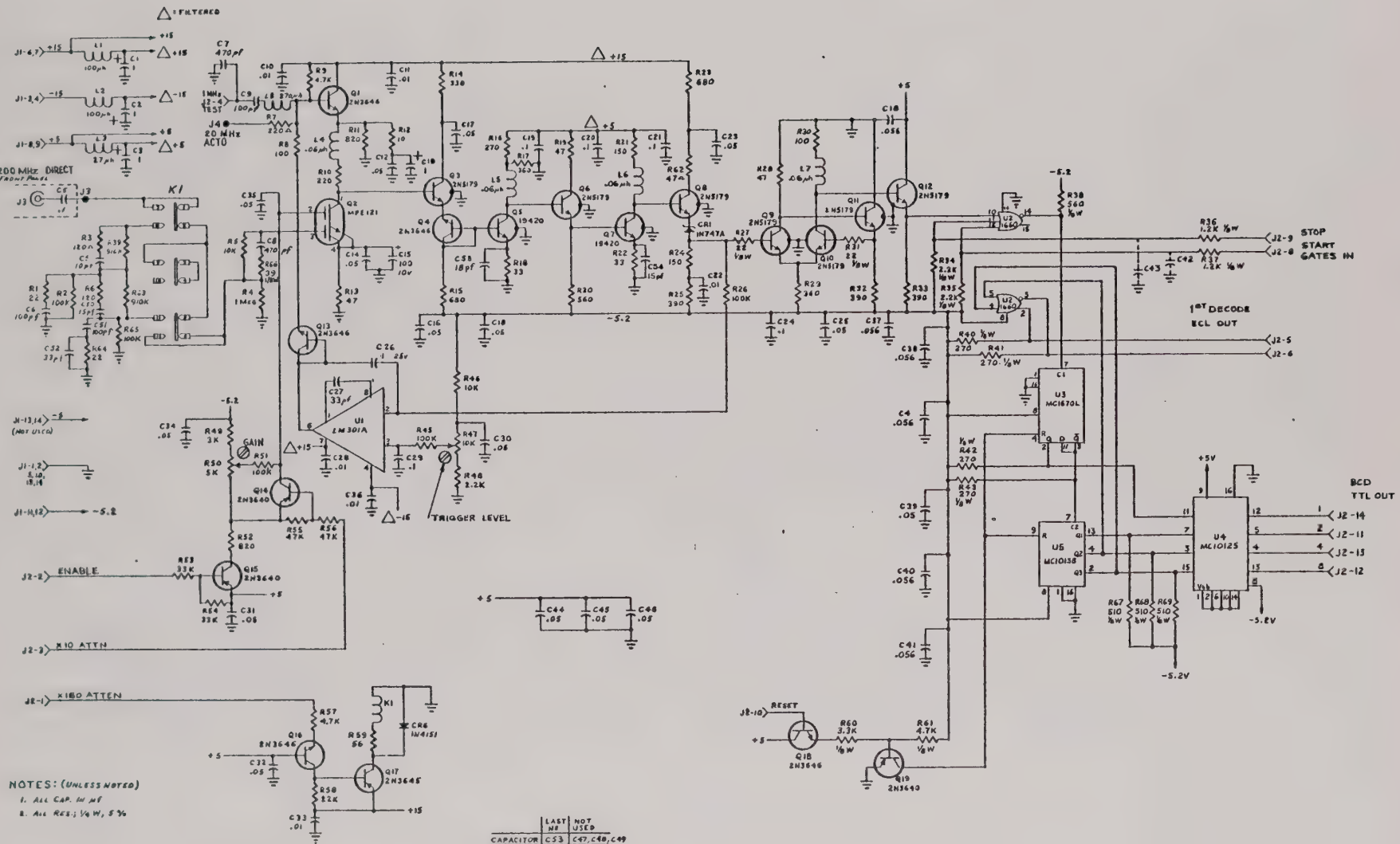
Ref.	Description	SD Part No.
	A3A1, Display Board Assembly	C07709901
	A3A1, Display Board Schematic	D03900001
DS1 thru DS9	Display, 7-segment 3-character	102404
XDS1 thru XDS9	Socket, Display 3-character	102446
	Header 2 x 13	117340



A3A1, DISPLAY P.C. ASSEMBLY C07709901



A4, 200 MHz AMP & DECADE ASSEMBLY, D39098L



	LAST NO	NOT USED
CAPACITOR	C53	C47, C48, C49
DIODE	CR6	2, 3, 4, 5
IC	U5	-
INDUCTOR	L8	-
RELAY	K1	-
RESISTOR	R69	R44
TRANSISTOR	Q19	-
CONNECTOR	J4	-

A4, 200 MHz AMP & DECADE SCHEMATIC, D39095H

PARTS LIST
A4 200 MHz AMP & DECADE PARTS LIST

Ref.	Description	SD Part No.
	200 MHz Amp & Decade P.C. Assembly	D39098L
	200 MHz Amp & Decade Schematic	D39095H
C1	Capacitor, 1 µF, 35 V, Tant	100082
C2	Same as C1	
C3	Same as C1	
C4	Capacitor, .056 µF, 100 V, Disc	116619
C5	Capacitor, 10 pF, 500 V, DM10	100272
C6	Capacitor, 100 pF, 500 V, DM10	100252
C7	Capacitor, 470 pF, 300 V, DM15	100221
C8	Same as C7	
C9	Same as C6	
C10	Capacitor, 0.01 µF, 100 V, Disc	100103
C11	Same as C10	
C12	Capacitor, 0.05 µF, 12 V	100122
C13	Same as C1	
C14	Same as C12	
C15	Capacitor, 100 µF, 10 V, Disc	100119
C16 thru C18	Same as C12	
C19	Capacitor, .1 µF, 10 V, Disc	100120
C20	Same as C19	
C21	Same as C19	
C22	Same as C10	
C23	Same as C12	
C24	Same as C19	
C25	Same as C12	
C26	Capacitor, 1 µF, 25 V, Cerm	100176
C27	Capacitor, 33 pF, 500 V, DM15	100175
C28	Same as C10	
C29	Same as C19	
C30	Same as C12	
C31	Same as C12	
C32	Same as C12	
C33	Same as C10	
C34	Same as C12	
C35	Same as C12	
C36	Same as C10	
C37	Same as C4	
C38	Same as C4	
C39	Same as C12	
C40	Same as C4	

A4 200 MHz AMP & DECADE PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
C41	Same as C4	
C42	Capacitor, Selected	
C43	Capacitor, Selected	
C44 thru C46	Same as C12	
C47 thru C49	Not Used	
C50	Capacitor, 15 pF, 500 V, DM10	100313
C51	Same as C6	
C52	Capacitor, 33 pF, 500 V, DM10	100314
C53	Capacitor, 18 pF, 500 V, DM10	100128
CR1	Diode, 1N747A	100469
CR2 thru CR5	Not Used	
CR6	Diode, 1N4151	100385
J1	Integrated Circuit Socket, 14 Pin	102433
J2	Same as J1	
J3	Terminal Lug	100482
J4	Connector, Post, AMP 61067-1	100562
K1	Relay, Printact #12BP3G	101294
L1	Inductor, 100 µH	101306
L2	Same as L1	
L3	Inductor, 27 µH	101308
L4	Inductor, 0.06 µH	101322
L5 thru L7	Same as L4	
L8	Inductor, 270 µH, WEE	101302
Q1	Transistor, 2N3646	101369
Q2	Transistor, MFE-121	101413
Q3	Transistor, 2N5179	101388
Q4	Same as Q1	
Q5	Same as Q3	
Q6	Same as Q3	
Q7	Same as Q5	
Q8 thru Q13	Same as Q3	
Q14	Transistor, 2N3640	101357
Q15	Same as Q14	

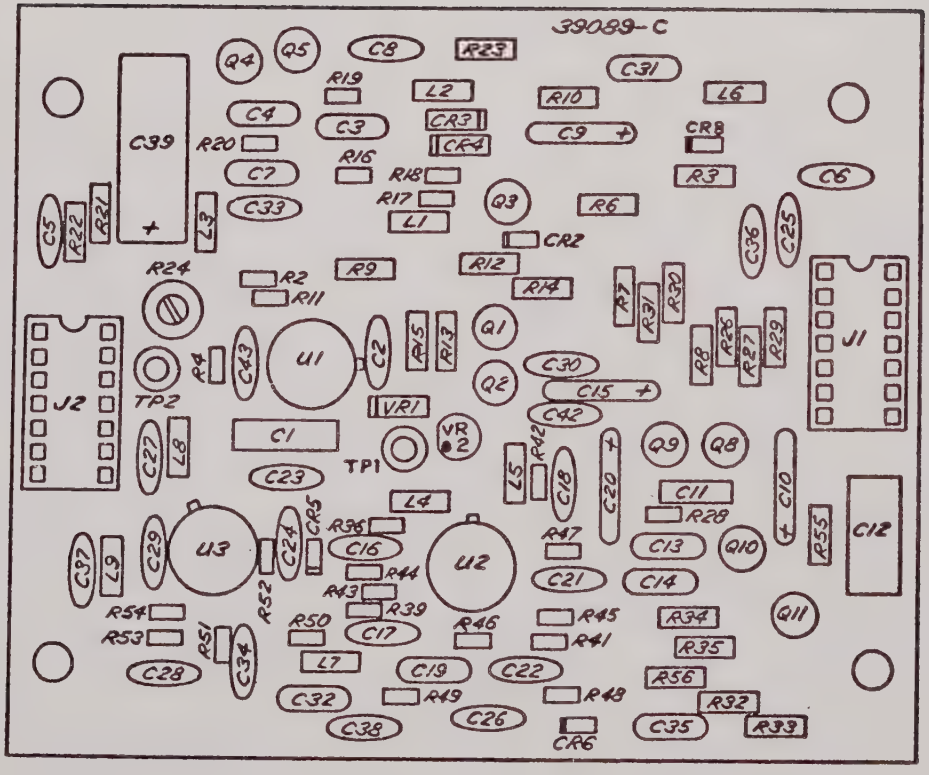
Ref.	Description	SD Part No.
Q16	Same as Q1	
Q17	Transistor, 2N3645	101367
Q18	Same as Q1	
Q19	Same as Q14	
R1	Resistor, 22 Ω, 1/4 W, 5%	101696
R2	Resistor, 100 k, 1/4 W, 5%	101558
R3	Resistor, 120 Ω, 1/4 W, 5%	101717
R4	Resistor, 1 MΩ , 1/4 W, 5%	101605
R5	Resistor, 10 k, 1/4 W, 5%	101570
R6	Same as R3	
R7	Resistor, 220 Ω, 1/4 W, 5%	101566
R8	Resistor, 100 Ω, 1/4 W, 5%	101609
R9	Resistor, 4.7 k, 1/4 W, 5%	101598
R10	Same as R7	
R11	Resistor, 820 Ω, 1/4 W, 5%	101567
R12	Resistor, 10 Ω, 1/4 W, 5%	101557
R13	Resistor, 47 Ω, 1/4 W, 5%	101560
R14	Resistor, 330 Ω, 1/4 W, 5%	101536
R15	Resistor, 680 Ω, 1/4 W, 5%	101669
R16	Resistor, 270 Ω, 1/4 W, 5%	101542
R17	Resistor, 360 Ω, 1/4 W, 5%	101745
R18	Resistor, 33 Ω, 1/4 W, 5%	101731
R19	Same as R13	
R20	Resistor, 560 Ω, 1/4 W, 5%	101583
R21	Resistor, 150 Ω, 1/4 W, 5%	101615
R22	Same as R18	
R23	Same as R15	
R24	Same as R21	
R25	Resistor, 390 Ω, 1/4 W, 5%	101592
R26	Same as R2	
R27	Resistor, 22 Ω, 1/8 W, 5%	101706
R28	Same as R13	
R29	Same as R17	
R30	Same as R8	
R31	Same as R27	
R32	Same as R25	
R33	Same as R25	
R34	Resistor, 2.2 k, 1/4 W, 5%	101719
R35	Same as R34	
R36	Resistor, 1.2 k, 1/4 W, 5%	101969
R37	Same as R36	
R38	Resistor, 560 Ω, 1/4 W, 5%	101710
R39	Resistor, 910 k, 1/4 W, 5%	101885
R40	Resistor, 270 Ω, 1/4 W, 5%	101703
R41	Same as R40	

A4 200 MHz AMP & DECADE PARTS LIST (Cont'd)

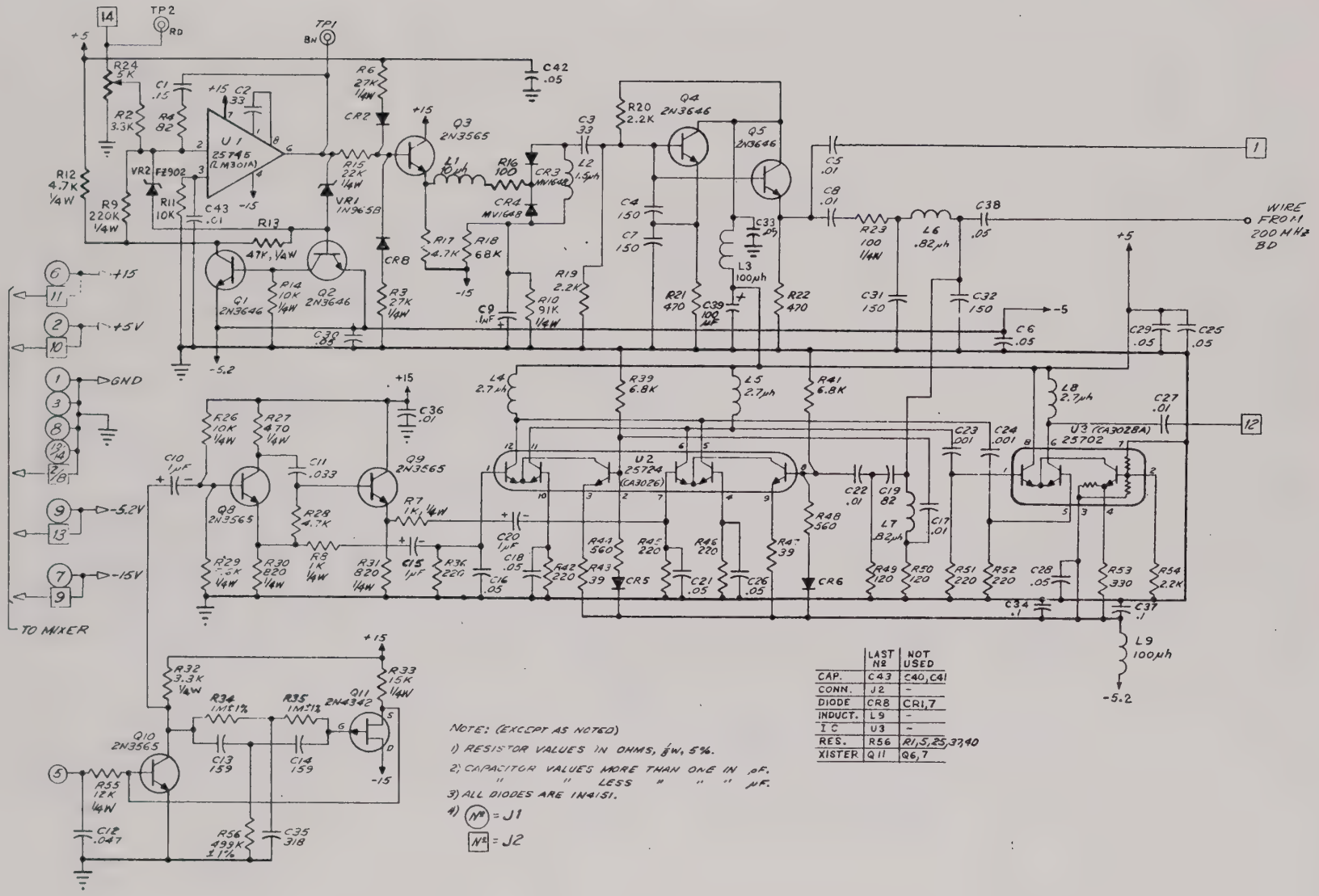
Ref.	Description	SD Part No.
R42	Same as R40	
R43	Same as R40	
R44	Not Used	
R45	Same as R2	
R46	Same as R5	
R47	Resistor, 10 k, Potentiometer, CTS 340	101916
R48	Resistor, 2.2 k, 1/4 W, 5%	101562
R49	Resistor, 3 k, 1/4 W, 5%	101548
R50	Resistor, 5 k, Potentiometer, CTS 340	101859
R51	Same as R2	
R52	Same as R11	
R53	Resistor, 33 k, 1/4 W, 5%	101576
R54	Same as R53	
R55	Resistor, 47 k, 1/4 W, 5%	101574
R56	Same as R55	
R57	Same as R9	
R58	Resistor, 22 k, 1/4 W, 5%	101572
R59	Resistor, 56 Ω, 1/4 W, 5%	101735
R60	Resistor, 3.3 k, 1/4 W, 5%	101713
R61	Resistor, 4.7 k, 1/4 W, 5%	101792
R62	Same as R13	
R63	Same as R39	
R64	Same as R1	
R65	Same as R2	
R66	Resistor, 39 Ω 1/8 W, 5%	101813
R67	Resistor, 510 Ω 1/8 W, 5%	101804
R68	Same as R67	
R69	Same as R67	
U1	Integrated Circuit, LM301A	025745
U2	Integrated Circuit, MC1660L	025777
U3	Integrated Circuit, MC1670L	025765
U4	Integrated Circuit, MC10125P	045226
U5	Integrated Circuit, MC10138P	103837
XQ1	Not Used	
XQ2	Transistor Pad	100921
XQ3	Same as XQ1	
XQ4	Not Used	
XQ5 thru XQ12	Same as XQ1	
XQ13 thru XQ16	Not Used	
XQ17	Transistor Pad	100666
XJ1	Insulator, 14 Hole	100993
XJ2	Same as XJ1	

NOTES

NOTES



A5, ACTO P.C. ASSEMBLY, C39090E



	LAST №	NOT USED
CAP.	C43	C40, C41
CONN.	J2	-
DIODE	CR8	CR1,7
INDUCT.	L9	-
I C	U3	-
RES.	R56	R1,5,25,37,40
XISTER	Q11	Q6,7

A5, ACTO SCHEMATIC, C39087D

A5 ACTO PARTS LIST

Ref.	Description	SD Part No.
	A5 ACTO P.C. Assembly	C39090
	A5 ACTO Schematic	C39087
C1	Capacitor, .15 µF, 100 V	C0237
C2	Capacitor, 33 pF, 500 V	C0531
C3	Capacitor, 33 pF, 500 V	C0531
C4	Capacitor, 150 pF, 500 V	C0537
C5	Capacitor, .01 µF, 100 V	C0556
C6	Capacitor, .05 µF, 12 V	C0672
C7	Capacitor, 150 pF, 500 V	C0537
C8	Capacitor, .01 µF, 100 V	C0556
C9	Capacitor, 1 µF, 35 V, Tant	C0524
C10	Capacitor, 1 µF, 35 V, Tant	C0524
C11	Capacitor, .033 µF, 100 V	C0735
C12	Capacitor, .047 µF, 200 V	C0700
C13	Capacitor, 159 pF, 500 V, 1%	C1146
C14	Capacitor, 159 pF, 500 V, 1%	C1146
C15	Capacitor, 1 µF, 35 V, Tant	C0524
C16	Capacitor, .05 µF, 12 V	C0672
C17	Capacitor, .01 µF, 100 V	C0556
C18	Capacitor, .05 µF, 12 V	C0672
C19	Capacitor, 82 pF, 500 V	C0535
C20	Capacitor, 1 µF, 35 V, Tant	C0524
C21	Capacitor, .05 µF, 12 V	C0672
C22	Capacitor, .01 µF, 100 V	C0556
C23	Capacitor, .001 µF, 1 KV	C0235
C24	Capacitor, .001 µF, 1 KV	C0235
C25	Capacitor, .05 µF, 12 V	C0672
C26		
C26	Capacitor, .05 µF, 12 V	C0672
C27	Capacitor, .01 µF, 100 V	C0556
C28	Capacitor, .05 µF, 12 V	C0672
C29	Capacitor, .05 µF, 12 V	C0672
C30	Capacitor, .05 µF, 12 V	C0672
C31	Capacitor, 150 pF, 500 V	C0537
C32	Capacitor, 150 pF, 500 V	C0537
C33	Capacitor, .05 µF, 12 V	C0672
C34	Capacitor, .1 µF, 10 V	C0661
C35	Capacitor, 318 pF, 500 V, 1%	C1145
C36	Capacitor, .01 µF, 100 V	C0556
C37	Capacitor, .1 µF, 10 V	C0661
C38	Capacitor, .05 µF, 12 V	C0672
C39	Capacitor, 100 µF, 10 V	C0660

A5 ACTO PARTS LIST (Cont'd)

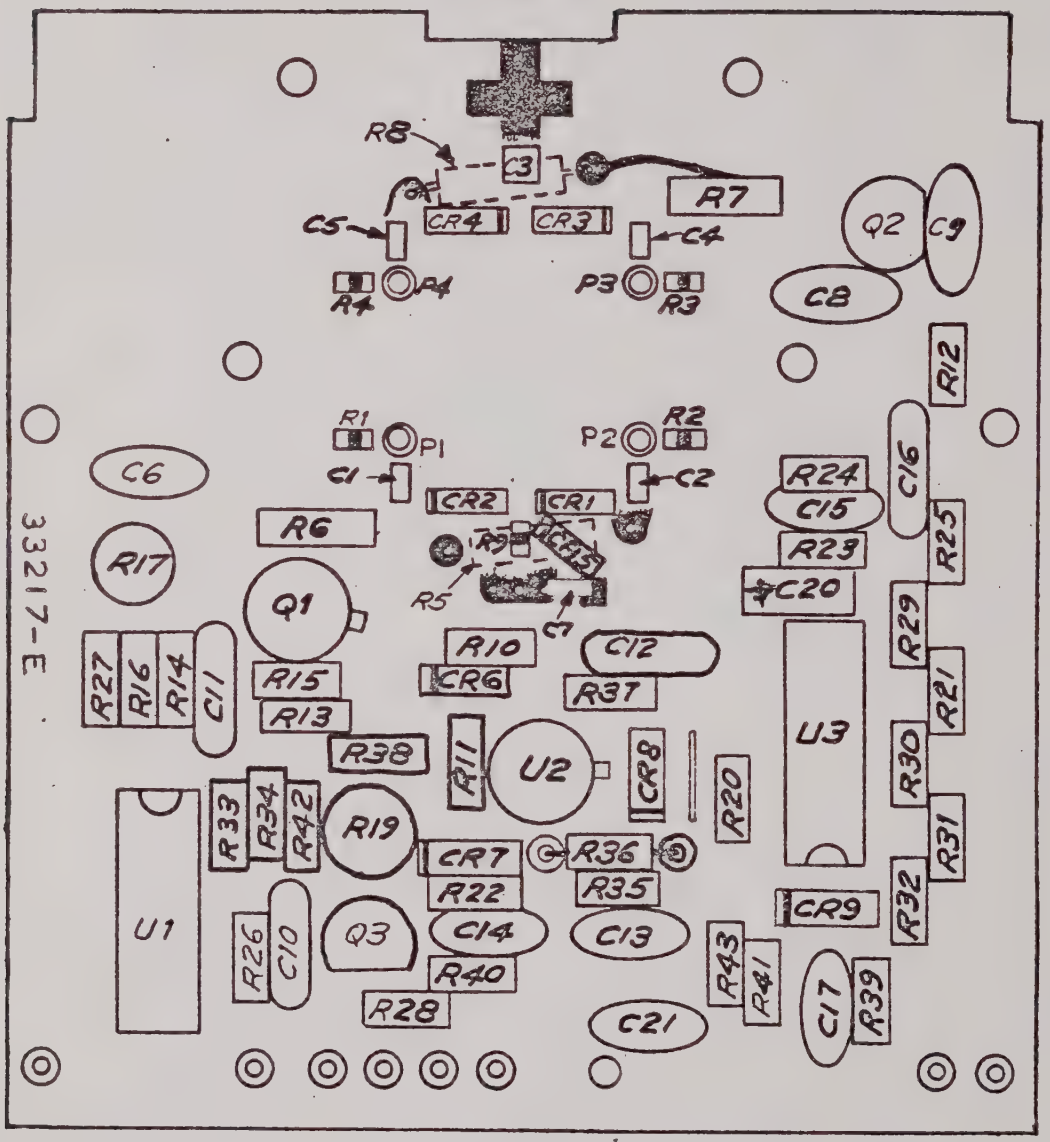
Ref.	Description	SD Part No.
C40	Not Used	
C41	Not Used	
C42	Capacitor, .05 µF, 12 V	C0672
C43	Capacitor, .01 µF, 100 V	C0556
CR1	Not Used	
CR2	Diode, 1N4151	CR0150
CR3	Diode, MV1648	CR0359
CR4	Diode, MV1648	CR0359
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
CR7	Not Used	
CR8	Diode, 1N4151	CR0150
J1	Connector, Socket, I.C., 14 Term	X0186
J2	Connector, Socket, I.C., 14 Term	X0184
L1	Inductor, 10 µH	L0153
L2	Inductor, 1.5 µH	L0164
L3	Inductor, 100 µH	L0156
L4	Inductor, 2.7 µH	L0165
L5	Inductor, 2.7 µH	L0165
L6	Inductor, .82 µH	L0163
L7	Inductor, .82 µH	L0163
L8	Inductor, 2.7 µH	L0165
L9	Inductor, 100 µH	L0156
Q1	Transistor, 2N3646	Q0218
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N3565	Q0237
Q4	Transistor, 2N3646	Q0218
Q5	Transistor, 2N3646	Q0218
Q6	Not Used	
Q7	Not Used	
Q8	Transistor, 2N3565	Q0237
Q9	Transistor, 2N3565	Q0237
Q10	Transistor, 2N3565	Q0237
Q11	Transistor, 2N4342	Q0243
R1	Not Used	
R2	Resistor, 3.3 k, 1/8 W, 5%	R1456
R3	Resistor, 27 k, 1/8 W, 5%	R0824
R4	Resistor, 82 Ω, 1/8 W, 5%	R1745
R5	Not Used	

A5 ACTO PARTS LIST (Cont'd)

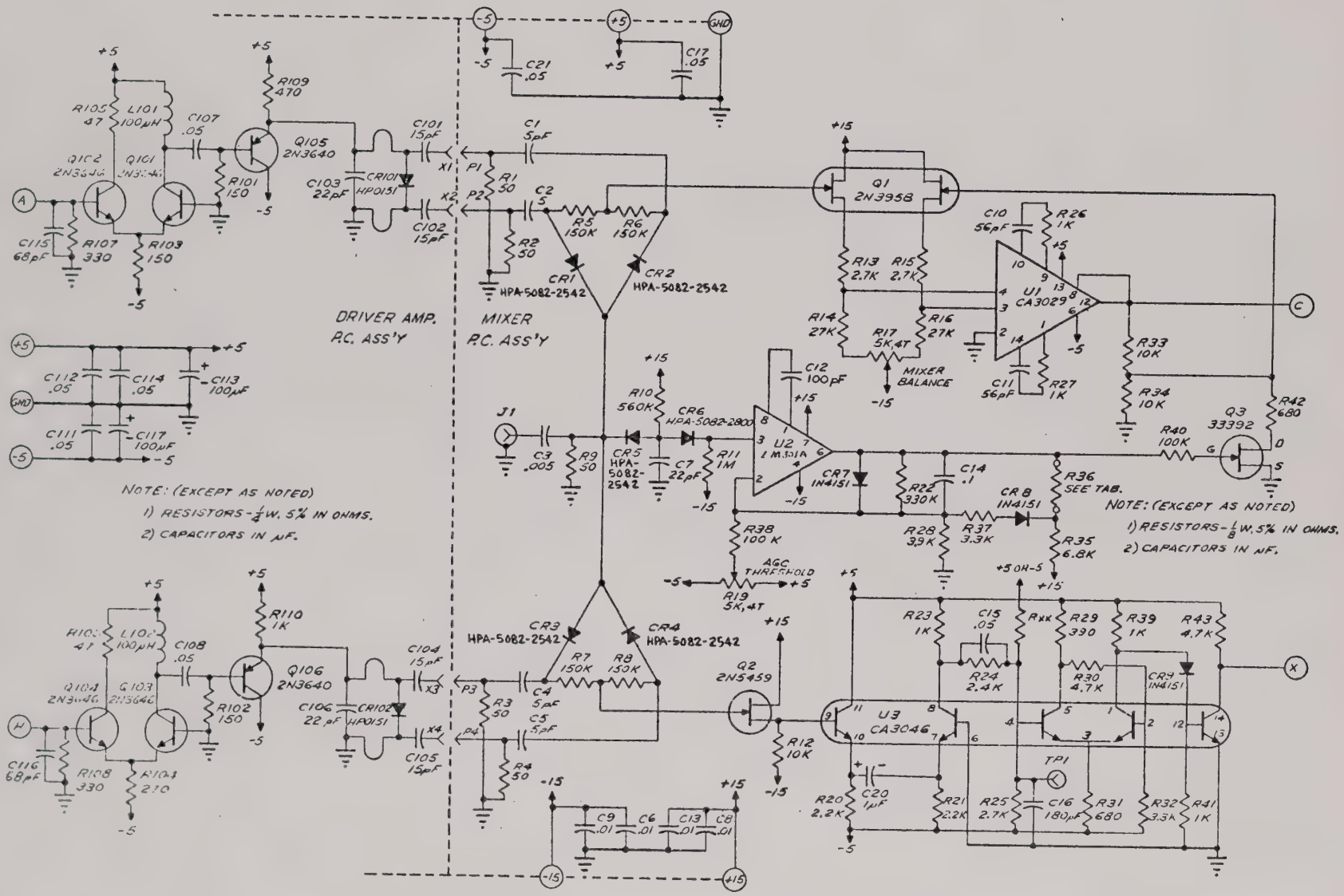
Ref.	Description	SD Part No.
R6	Resistor, 27 k, 1/8 W, 5%	R0824
R7	Resistor, 1 k, 1/8 W, 5%	R0765
R8	Resistor, 1 k, 1/8 W, 5%	R0765
R9	Resistor, 220 k, 1/4 W, 5%	R0967
R10	Resistor, 91 k, 1/4 W, 5%	R1481
R11	Resistor, 10 k, 1/8 W, 5%	R1437
R12	Resistor, 4.7 k, 1/4 W, 5%	R0892
R13	Resistor, 47 k, 1/4 W, 5%	R0777
R14	Resistor, 10 k, 1/4 W, 5%	R0766
R15	Resistor, 22 k, 1/4 W, 5%	R0768
R16	Resistor, 100 Ω, 1/8 W, 5%	R1441
R17	Resistor, 4.7 k, 1/8 W, 5%	R1733
R18	Resistor, 68 k, 1/8 W, 5%	R1849
R19	Resistor, 2.2 k, 1/8 W, 5%	R1476
R20	Resistor, 2.2 k, 1/8 W, 5%	R1476
R21	Resistor, 470 Ω, 1/8 W, 5%	R1451
R22	Resistor, 470 Ω, 1/8 W, 5%	R1451
R23	Resistor, 100 Ω, 1/4 W, 5%	R0966
R24	Resistor, VAR., 5 k, 2 W, 30%	R2187
R25	Not Used	
R26	Resistor, 10 k, 1/4 W, 5%	R0766
R27	Resistor, 470 Ω, 1/4 W, 5%	R1044
R28	Resistor, 4.7 k, 1/8 W, 5%	R1733
R29	Resistor, 5.6 k, 1/4 W, 5%	R0821
R30	Resistor, 820 Ω, 1/4 W, 5%	R0762
R31	Resistor, 820 Ω, 1/4 W, 5%	R0762
R32	Resistor, 3.3 k, 1/4 W, 5%	R0742
R33	Resistor, 15 k, 1/4 W, 5%	R0728
R34	Resistor, 1 MΩ, 1/8 W, 5%	R2371
R35	Resistor, 1 MΩ, 1/8 W, 5%	R2371
R36	Resistor, 220 Ω, 1/8 W, 5%	R1743
R37	Not Used	
R38	Not Used	
R39	Resistor, 6.8 k, 1/8 W, 5%	R1459
R40	Not Used	
R41	Resistor, 6.8 k, 1/8 W, 5%	R1459
R42	Resistor, 220 Ω, 1/8 W, 5%	R1743
R43	Resistor, 39 Ω, 1/8 W, 5%	R1829
R44	Resistor, 560 Ω, 1/8 W, 5%	R1452
R45	Resistor, 220 Ω, 1/8 W, 5%	R1743
R46	Resistor, 220 Ω, 1/8 W, 5%	R1743

A5 ACTO PARTS LIST (Cont'd)

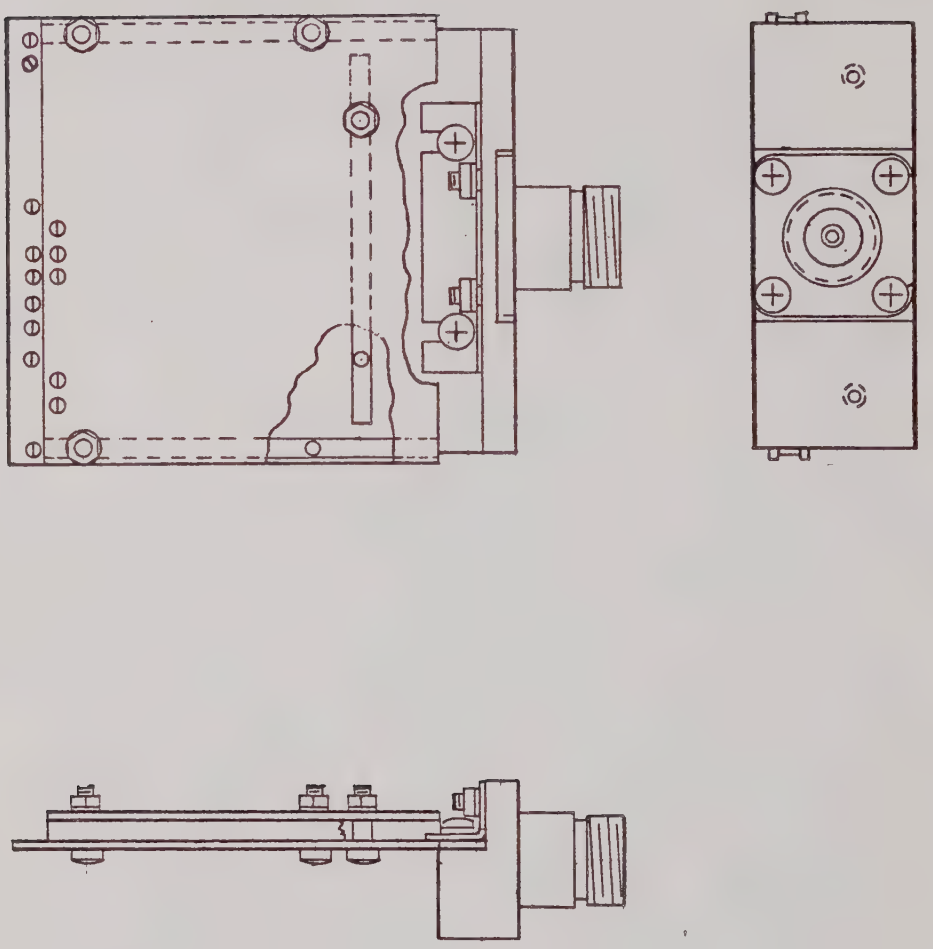
Ref.	Description	SD Part No.
R47	Resistor, 39 Ω, 1/8 W, 5%	R1829
R48	Resistor, 560 Ω, 1/8 W, 5%	R1452
R49	Resistor, 120 Ω, 1/8 W, 5%	R2459
R50	Resistor, 120 Ω, 1/8 W, 5%	R2459
R51	Resistor, 220 Ω, 1/8 W, 5%	R1743
R52	Resistor, 220 Ω, 1/8 W, 5%	R1743
R53	Resistor, 330 Ω, 1/8 W, 5%	R1444
R54	Resistor, 2.2 k, 1/8 W, 5%	R1476
R55	Resistor, 12 k, 1/4 W, 5%	R0759
R56	Resistor, 499 k, 1/8 W, 1%	R2372
TP1	Test Point, Brown	E0284
TP2	Test Point, Red	E0279
U1	Integrated Circuit, LM301A	25745
U2	Integrated Circuit, CA3026	25724
U3	Integrated Circuit, CA3028A	25702
VR1	Zener, 1N965B	CR0139
VR2	Zener, FZ902	26015850
XJ1 & J2	Retainer, Plug	A39976
XJ1 & J2	Insulator, 14 Hole	H1958



A6, MIXER P.C. ASSEMBLY, C33218J



A6, MIXER & DRIVER AMP SCHEMATIC, C27988L



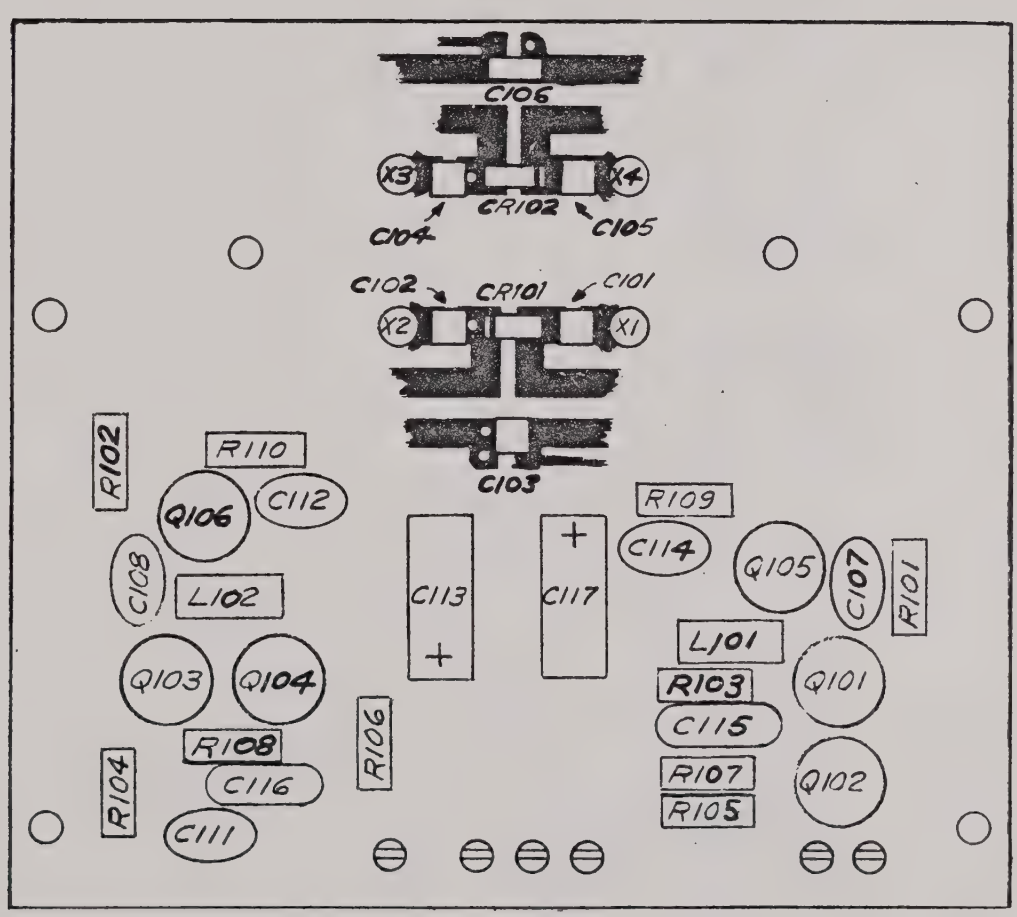
A6, MIXER FINAL ASSEMBLY, C33351B

A6 MIXER PARTS LIST

Ref.	Description	SD Part No.
	Mixer P.C. Assembly	C33218C
	Mixer Schematic	C27988C
C1	Capacitor, 5 pF, Chip	C1187
C2	Capacitor, 5 pF, Chip	C1187
C3	Capacitor, .005 µF, Chip	C1245
C4	Capacitor, 5 pF, Chip	C1187
C5	Capacitor, 5 pF, Chip	C1187
C6	Capacitor, .01 µF, 100 V, Disc	C0556
C7	Capacitor, 22 pF, 25 V, Disc, Chip	C1177
C8	Capacitor, .01 µF, 100 V, Disc	C0556
C9	Capacitor, .01 µF, 100 V, Disc	C0556
C10	Capacitor, 56 pF, 500 V, DM	C0882
C11	Capacitor, 56 pF, 500 V, DM	C0882
C12	Capacitor, 100 pF, 500 V, DM	C0536
C13	Capacitor, .01 µF, 100 V, Disc	C0556
C14	Capacitor, .1 µF, 10 V, Disc	C0661
C15	Capacitor, .05 µF, 12 V, Disc	C0672
C16	Capacitor, 180 pF, 500 V, DM	C1138
C17	Capacitor, .05 µF, 12 V, Disc	C0672
C18	Not Used	
C19	Not Used	
C20	Capacitor, 1 µF, 35 V, Tant	C0524
C21	Capacitor, .05 µF, 12 V, Disc	C0672
CR1	Diode, HPA-5082-2542	CR0358
CR2	Diode, HPA-5083-2542	CR0358
CR3	Diode, HPA-5083-2542	CR0358
CR4	Diode, HPA-5083-2542	CR0358
CR5	Diode, HPA-5083-2542	CR0358
CR6	Diode, HPA 5082-2800	CR0363
CR7	Diode, 1N4151	CR0150
CR8	Diode, 1N4151	CR0150
CR9	Diode, 1N4151	CR0150
Q1	Transistor, 2N3958	26015100
Q2	Transistor, 2N5459	Q0264
Q3	Transistor, SD Spec 33392	33392
R1	Resistor, 50 Ω, Chip	R2494
R2	Resistor, 50 Ω, Chip	R2494
R3	Resistor, 50 Ω, Chip	R2494
R4	Resistor, 50 Ω, Chip	R2494
R5	Resistor, 150 k, 1/4 W, 1%, MF	R2421

A6 MIXER PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R6	Resistor, 150 k, 1/4 W, 1%, MF	R2421
R7	Resistor, 150 k, 1/4 W, 1%, MF	R2421
R8	Resistor, 150 k, 1/4 W, 1%, MF	R2421
R9	Resistor, 50 Ω, Chip	R2494
R10	Resistor, 560 k, 1/8 W, 5%	R2536
R11	Resistor, 1 M, 1/8 W, 5%	R1435
R12	Resistor, 10 k, 1/8 W, 5%	R1437
R13	Resistor, 2.7 k, 1/8 W, 5%	R1749
R14	Resistor, 27 k, 1/8 W, 5%	R2432
R15	Resistor, 2.7 k, 1/8 W, 5%	R1749
R16	Resistor, 27 k, 1/8 W, 5%	R2432
R17	Resistor, 5 k, Potentiometer 4 Turn	R2697
R18	Not Used	
R19	Resistor, 5 k, Potentiometer 4 Turn, 1/8 W, 5%	R2697
R20	Resistor, 2.2 k, 1/8 W, 5%	R1476
R21	Resistor, 2.2 k, 1/8 W, 5%	R1476
R22	Resistor, 330 k, 1/8 W, 5%	R2535
R23	Resistor, 1 k, 1/8 W, 5%	R1453
R24	Resistor, 2.4 k, 1/8 W, 5%	R2358
R25	Resistor, 2.7 k, 1/8 W, 5%	R1749
R26	Resistor, 1 k, 1/8 W, 5%	R1453
R27	Resistor, 1 k, 1/8 W, 5%	R1453
R28	Resistor, 3.9 k, 1/8 W, 5%	R1457
R29	Resistor, 390 Ω, 1/8 W, 5%	R1450
R30	Resistor, 4.7 k, 1/8 W, 5%	R1733
R31	Resistor, 680 Ω, 1/8 W, 5%	R2461
R32	Resistor, 3.3 k, 1/8 W, 5%	R1456
R33	Resistor, 10 k, 1/8 W, 5%	R1437
R34	Resistor, 10 k, 1/8 W, 5%	R1437
R35	Resistor, 6.8 k, 1/8 W, 5%	R1459
R36	Resistor Selected	
R37	Resistor, 3.3 k, 1/8 W, 5%	R1456
R38	Resistor, 100 k, 1/8 W, 5%	R2465
R39	Resistor, 1 k, 1/8 W, 5%	R1453
R40	Resistor, 100 k, 1/8 W, 5%	R2465
R41	Resistor, 1 k, 1/8 W, 5%	R1453
R42	Resistor, 680 Ω, 1/8 W, 5%	R2461
R43	Resistor, 4.7 k, 1/8 W, 5%	R1733
U1	Integrated Circuit, CA3029	25757
U2	Integrated Circuit, LM301A	25745
U3	Integrated Circuit, CA3046	25725



A6, DRIVER AMP P.C. ASSEMBLY, C3321G

A6 DRIVER AMP PARTS LIST

Ref.	Description	SD Part No.
	A6 Driver Amp P.C. Assembly	C33221C
	A6 Driver Amp Schematic	C27988C
C101	Capacitor, 15 pF, Chip	C1163
C102	Capacitor, 15 pF, Chip	C1163
C103	Capacitor, 22 pF, Chip	C1177
C104	Capacitor, 15 pF, Chip	C1163
C105	Capacitor, 15 pF, Chip	C1163
C106	Capacitor, 22 pF, Chip	C1177
C107	Capacitor, .05 µF, 12 V	C0672
C108	Capacitor, .05 µF, 12 V	C0672
C109	Not Used	
C110	Not Used	
C111	Capacitor, .05 µF, 12 V	C0672
C112	Capacitor, .05 µF, 12 V	C0672
C113	Capacitor, 100 µF, 10 V	C0660
C114	Capacitor, .05 µF, 12 V	C0672
C115	Capacitor, 68 pF, 500 V	C0635
C116	Capacitor, 68 pF, 500 V	C0635
C117	Capacitor, 100 µF, 10 V	C0660
CR101	Diode, HP0151	CR0269
CR102	Diode, HP0151	CR0269
L101	Inductor, 100 µH, 10%	L0073
L102	Inductor, 100 µH, 10%	L0073
Q101	Transistor, 2N3646	Q0218
Q102	Transistor, 2N3646	Q0218
Q103	Transistor, 2N3646	Q0218
Q104	Transistor, 2N3646	Q0218
Q105	Transistor, 2N3640	Q0178
Q106	Transistor, 2N3640	Q0178
R101	Resistor, 150 Ω, 1/4 W, 5%	R0983
R102	Resistor, 150 Ω, 1/4 W, 5%	R0983
R103	Resistor, 150 Ω, 1/4 W, 5%	R0983
R104	Resistor, 270 Ω, 1/4 W, 5%	R0694
R105	Resistor, 47 Ω, 1/4 W, 5%	R0743
R106	Resistor, 47 Ω, 1/4 W, 5%	R0743
R107	Resistor, 330 Ω, 1/4 W, 5%	R0662
R108	Resistor, 330 Ω, 1/4 W, 5%	R0662
R109	Resistor, 470 Ω, 1/4 W, 5%	R1044
R110	Resistor, 1 k, 1/4 W, 5%	R0765

CHAPTER 7
STANDARD OPTIONS

7.1 INTRODUCTION

The Standard Options available for the SD Model 6053/3 Frequency Counter are described in the following sections. These are extra cost items to tailor your unit for specific application. Non-standard Options may be requested and will be described in this chapter when applicable.

OPTION 10
OSCILLATOR (B1)

The B1 Option provides this instrument with a medium stability oscillator.

The B1 Oscillator specifications are as follows:

AGING RATE: ±7 parts in 10^9/24 hrs. // ±2 parts in 10^8/24 hours.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 30 days // 72 hours.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: ±5 parts in 10^9 rms.

LONG-TERM AGING RATE: ±3 parts in 10^9/24 hours after 45 day dynamic.

VARIATION WITH TEMPERATURE: ±5 parts in 10^9/C° from -20° to +50°C.

10% CHANGE IN LINE VOLTAGE: <±2 parts in 10^{10}.

Parts List

Ref.	Description	SD Part No.
U1	Oscillator, Heated B1	Y0023

OPTION 10
OSCILLATOR (B1)

The B1 Option provides this instrument with a medium stability oscillator.

The B1 Oscillator specifications are as follows:

AGING RATE: ±7 parts in 10^9/24 hrs. // ±2 parts in 10^8/24 hours.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 30 days // 72 hours.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: ±5 parts in 10^9 rms.

LONG-TERM AGING RATE: ±3 parts in 10^9/24 hours after 45 day dynamic.

VARIATION WITH TEMPERATURE: ±5 parts in 10^9/C° from -20° to +50°C.

10% CHANGE IN LINE VOLTAGE: <±2 parts in 10^{10}.

Parts List

Ref.	Description	SD Part No.
U1	Oscillator, Heated B1	Y0023

OPTION 12
OSCILLATOR (B)

The B Option provides the instrument with a high stability oscillator. The B Oscillator, unlike the standard 1 MHz Oscillator, has an output frequency of 3 MHz. A divide-by-three circuit has been added to convert the oscillator's output frequency to the required 1 MHz reference frequency.

The B Option comprises the B Oscillator, a separate power supply, and a divide-by-three circuit (refer to the Oscillator Power Supply). The improved specifications are listed below:

AGING RATE: 1 part in 10^9/24 hrs.

WARM-UP TIME TO REACH SPECIFIED AGING RATE: 72 hrs.

SHORT-TERM STABILITY AVERAGED OVER 1 SECOND: 1 part in 10^{10} rms.

LONG-TERM AGING RATE: ±3 parts in 10^8/30 days.

VARIATION WITH TEMPERATURE (AVERAGE 2 PARTS IN 10^{10}/°C): ±4 parts in 10^9 over 20° change within -20° to +50°C.

10% CHANGE IN LINE VOLTAGE: ±5 parts in 10^{10}.

Parts List

Ref.	Description	SD Part No.
A7	Oscillator Power P.C. Assembly	B39487
C9	Capacitor, 500 µF, 50 V	C1243
T2	Transformer	19805
U1	Oscillator, B	C33427
	Bracket, MT'g., Osc.	B39044
	Wire List	A39551

OPTION 13
OSCILLATOR (B4)

The B4 Option provides the instrument with a very high stability oscillator. Specifications for this oscillator are the following:

FREQUENCY OUTPUT: 1 MHz.

STABILITY:

Temperature -- Less than 5 parts in 10^{11}/C° from 0 to +15°C.

Aging Rate -- Less than 5 parts in 10^{10}/24 hours after warm-up. Up to 72 hrs. may be required to reach this aging rate after lengthy "off" periods of time.

Line Voltage -- Less than ±1 part in 10^{10} for a 10% voltage change.

Short Term -- Less than 5 parts in 10^{11} rms with measurement averaging time of one second under constant enviromental and line voltage conditions.

Frequency Retrace -- After up to 24 hours of shutdown, one hour is required to reach within 5 parts in 10^{9} of the frequency that existed at the time of turn off.

FREQUENCY ADJUST:

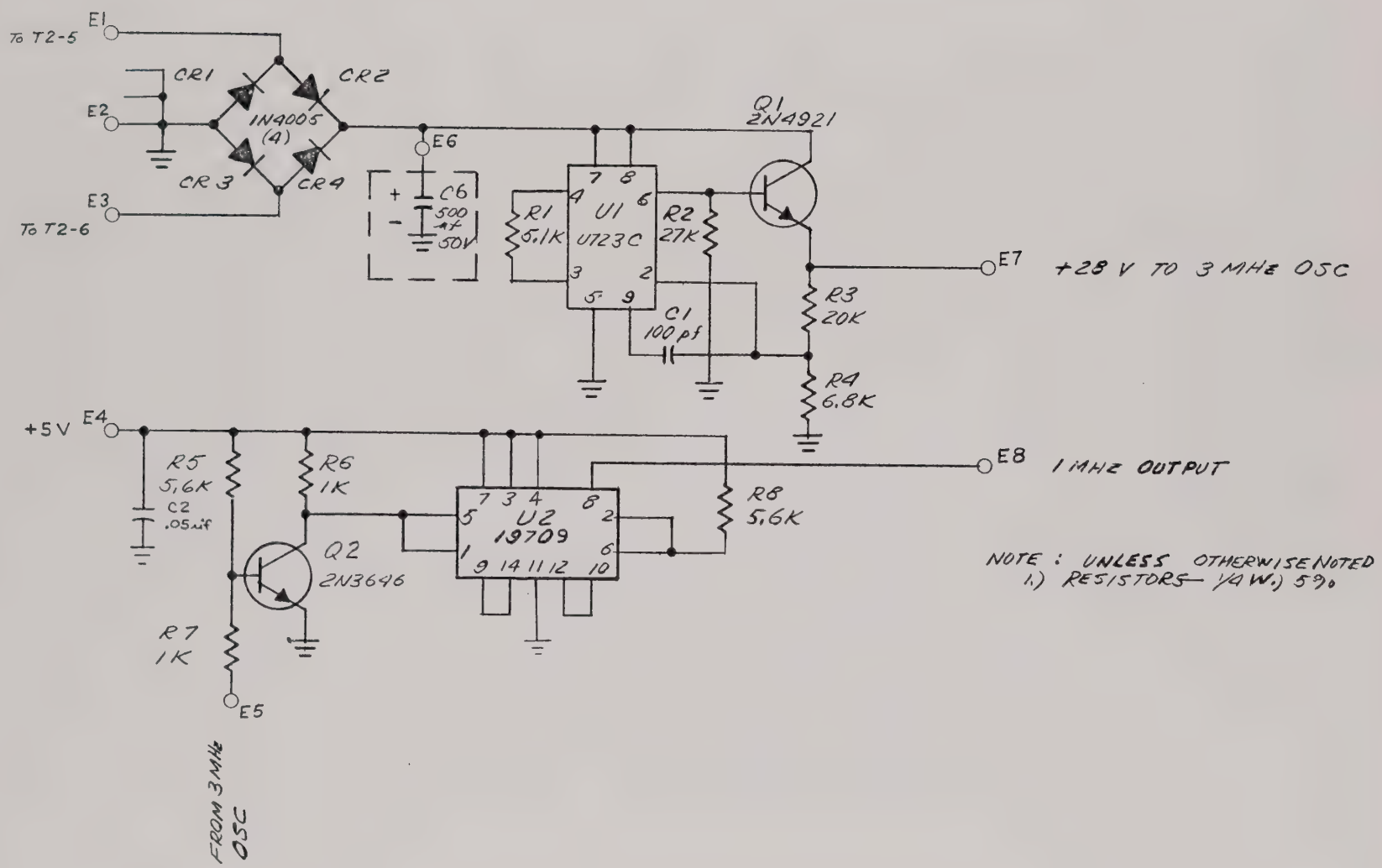
Range (Coarse) -- ±2 parts in 10^{6}.

Range (fine) -- ±7 parts in 10^{8}.

Resolution -- ±1 part in 10^{10}.

Parts List

Ref.	Description	SD Part No.
A7	Oscillator Power P.C. Assembly	B39487
C9	Capacitor, 500 µF, 50 V	C1243
T1	Transformer	19805
U1	Oscillator, B4	C33429
	Wire List	A39551



U1, 3MHz OSCILLATOR SCHEMATIC, B3949OR1

3 MHz OSCILLATOR AND POWER SUPPLY PARTS LIST

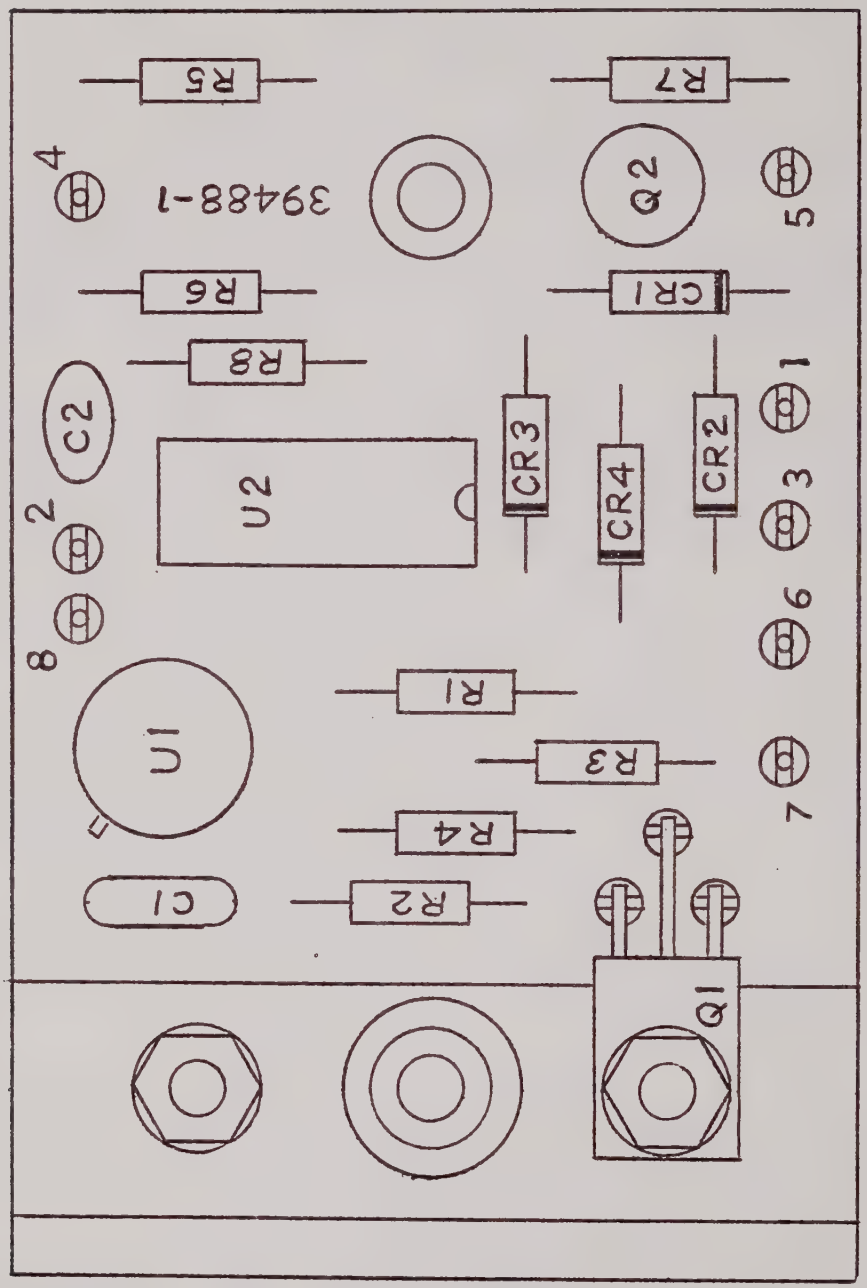
Ref.	Description	SD Part No.
	3 MHz Oscillator and Power Supply Assembly	B39487A
	3 MHz Oscillator and Power Supply Schematic	B39490A
C1	Capacitor, 100 pF, 500 V, 5%	C0536
C2	Capacitor, .05 µF, 12 V	C0672
CR1	Diode, 1N4005	CR0284
CR2	Diode, 1N4005	CR0284
CR3	Diode, 1N4005	CR0284
CR4	Diode, 1N4005	CR0284
Q1	Transistor, 2N4921	Q0267
Q2	Transistor, 2N3646	Q0218
R1	Resistor, 5.1 k, 1/4 W, 5%	R0693
R2	Resistor, 27 k, 1/4 W, 5%	R0824
R3	Resistor, 20 k, 1/4 W, 5%	R0964
R4	Resistor, 6.8 k, 1/4 W, 5%	R0696
R5	Resistor, 5.6 k, 1/4 W, 5%	R0821
R6	Resistor, 1 k, 1/4 W, 5%	R0765
R7	Resistor, 1 k, 1/4 W, 5%	R0765
R8	Resistor, 5.6 k, 1/4 W, 5%	R0821
U1	Integrated Circuit, U723C	25756
U2	Integrated Circuit, 7473N	19709
	Heatsink	A39486

CIRCUIT DESCRIPTION
A7 OSCILLATOR, POWER SUPPLY
SCHEMATIC #B39490R1
(used with OPTIONS 11, 12, 13)

This board contains two circuits: a regulated +28 V dc power supply and a divide-by-3 circuit.

The Oscillator Power Supply consists of a full wave bridge CR1, 2, 3, 4 which supplies 28 Volts dc to regulator U1 and series pass transistor Q1. The necessary regulated 28 Volts is then fed to the oscillator.

The divide-by-3 circuit takes the 3 MHz signal from the oscillator and uses Q2 as a buffer amplifier to supply a 3 MHz signal at the proper level to the input of the divide-by-3 integrated circuit, U2. U2 divides the 3 MHz signal by 3 and produces the 1 MHz signal use by the counter.



U1, 3MHz OSCILLATOR ASSEMBLY, B39487R1

OPTION 15
DECADE INDICATORS (E)

The E Option adds one readout digit to the standard instrument. When adding option E, remove and add one each jumper wire as shown on drawing D33997.

Parts List

Ref.	Description	SD Part No.
U51	Integrated Circuit, SN7441N	19707
U52	Integrated Circuit, SN7075N	25731
U53	Integrated Circuit, SN7090N	25732
V8	Tube, Readout, NL5859S	V0131

OPTION 16
DECADE INDICATORS (EE)

The EE Option adds two readout digits to the standard unit. When adding option EE, remove one each jumper wire as shown on drawing D33997.

Parts List

Ref.	Description	SD Part No.
U51	Integrated Circuit, SN7441N	19707
U52	Integrated Circuit, SN7075N	25731
U53	Integrated Circuit, SN7090N	25732
U54	Integrated Circuit, SN7441N	19707
U55	Integrated Circuit, SN7075N	25731
U56	Integrated Circuit, SB7090N	25732
V8	Tube, Readout, NL5859S	V0131
V9	Tube, Readout, NL5859S	V0131

OPTION 17
DATA OUTPUT (D3)

BCD pin assignments:

DIGIT DISPLAYED	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	2	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41

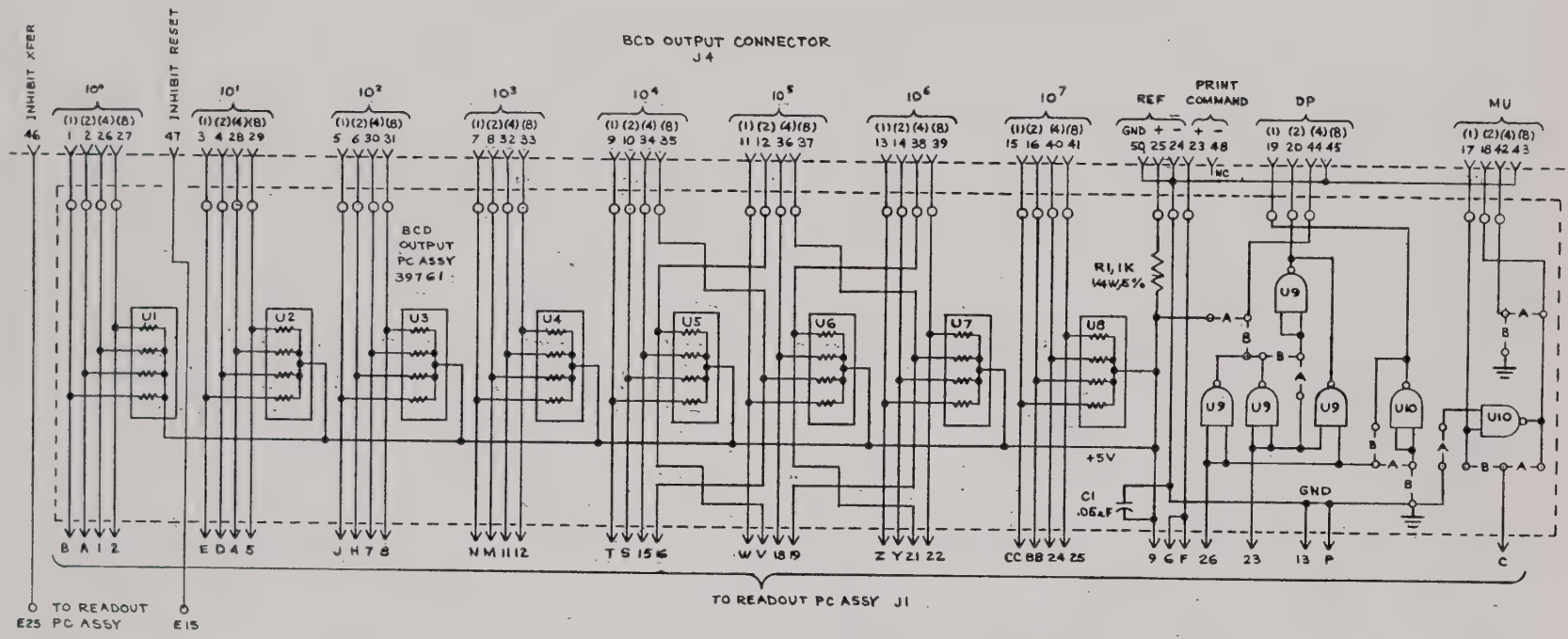
ANNUNCIATION		
Measurement Unit	1	17
	2	18
	4	42
	8	43
Decimal Point	1	19
	2	20
	4	44
	8	45

RECORDER CONTROL	
+ Reference	25
- Reference	24
Instrument Ground	50
Print Command *	48
Inhibit Transfer	47

* 0 → +15 volt transition at end of count.

J4 (BCD OUT) Connector = Amphenol 57-40500
Mating Connector = Amphenol 57-30500

OPTION 17 (D3) BCD ASSEMBLY A39897B



		1	2	4	8
DP	10^0	0	Ø	0	0
	10^1	1	0	Ø	0
	10^2	0	1	0	0
	10^3	1	1	0	0
	10^4	0	0	1	Ø
	10^5	1	0	1	Ø
	10^6	0	1	1	0
	10^7	1	1	1	0
MU	MHz	1	0	0	0
	KHz	0	1	Ø	Ø
	µS	1	0	1	Ø
	mS	0	0	1	0
	SEC	1	1	0	0

NOTES

1) U1 THRU U8 ARE 5K, 1/10W, 20% RESISTOR NETWORKS 27867
2) U9 & U10 ARE SN1584GN OR EQUIV. PIN 7 GND, PIN 14 +5V
3) JUMPERS 0–A–0 INSTALLED FOR MODELS 6052 & 6053
4) JUMPERS 0–B–0 INSTALLED FOR MODELS 6050 & 6051

OPTION 17 (D3) BCD SCHEMATIC 639113D

OPTION 17 (D3) BCD PARTS LIST

Ref.	Description	SD Part No.
	BCD Output Assembly	A39897D
	BCD Output Schematic	C39113D
C1	Capacitor, .05 µF, 12 V, Disc	C0762
R1	Resistor, 1 k, 1/4 W, 5%	R0765
U1	Resistor Network, 5 k, 1/10 W, 20%	27867
U2	Resistor Network, 5 k, 1/10 W, 20%	27867
U3	Resistor Network, 5 k, 1/10 W, 20%	27867
U4	Resistor Network, 5 k, 1/10 W, 20%	27867
U5	Resistor Network, 5 k, 1/10 W, 20%	27867
U6	Resistor Network, 5 k, 1/10 W, 20%	27867
U7	Resistor Network, 5 k, 1/10 W, 20%	27867
U8	Resistor Network, 5 k, 1/10 W, 20%	27867
U9	Integrated Circuit, SN15846N	19716
U10	Integrated Circuit, SN15846N	19716

OPTION 20
REMOTE OPERATION (P)

Remote control pin assignments:

PIN NO.	CONTROLS
1	Inhibit Reset
2	Reset (closure to ground will reset instrument only when gate is closed.)
4	FUNCTION "B"
5	FUNCTION "C"
6	FUNCTION "D"
8	RESOLUTION "B"
9	RESOLUTION "C"
10	RESOLUTION "D"
12	+5 V
14	Ground

DESIRED FUNCTION	GROUND PINS	DESIRED RESOLUTION	GROUND PINS
ACTO	4 & 6	10^{-1}	NONE
TEST	6	1	8
X1	NONE	10	9
X10	4	10^{2}	8 & 9
X100	5	10^{3}	8 & 10
X1000	4 & 5	10^{4}	9 & 10
		10^{5}	8, 9, & 10

J4 (REMOTE CONTROL) = Amphenol 57-40140
Mating Connector = Amphenol 57-30140

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